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A Factory Manager Speaks on Production Control and Safety

An Interview Article

By W. E. Irish
Associate Editor, *American Machinist*

DEFINITE and efficient production control is essential to the business of building typewriters. Without it we could never hope to keep track on progress of the parts from rough stock to the finished product. An idea of the magnitude of the problem can be gained from the fact that exact knowledge must be had of 2,300 parts in 9,200 operations, if we are to keep in control of our direct production.

When we say a definite and efficient system is necessary, we mean just that, but this should by no means convey an impression of many books of account or of an army of clerks to keep up with the 9,200 steps we take. Our system has been built up with just the opposite goal in view. In fact, we have based our methods of production control on the premise that the system must fit itself to the work in hand and grow up from a very simple beginning.

> Production control methods must be based on the premise that the system shall fit itself to the work in hand and shall grow up from a very simple beginning to a complex reality. Each step in its growth must be aimed toward more comprehensive control without material change in simplicity. Success is then measurable in increased productivity of the direct working force and a corresponding decrease in overhead cost

Each step in its growth must be aimed toward more comprehensive control without material change in simplicity, and we measure our success by the increased productivity of the direct working force and a corresponding decrease in overhead outlay.

With these points in view, we have installed a chief dispatcher and a balance clerk in our factory production office to act as the nerve center of production, which can be considered as starting at the rough stores and coming to completion through the finished stores to the assembly.

The chief dispatcher starts, and keeps, his fingers on the progress of all parts between these two points. The balance clerk keeps a continuous record of the conditions at the start, during a run and at the finish, acting therefore as a check and a source of information to the chief dispatcher.

On each class of material and each individual part we have established what we call an order point. This point in each case is based on our past experience as to market conditions that may affect delivery to us and as to time required to put a given part or set of parts through the shop. As this order point is approached, the men in charge of the stores, either rough or finished, notify the chief dispatcher. At the same time records of production, showing actual additions and withdrawals, continue to come across the balance clerk's desk and are recorded. He also notifies the chief dispatcher as the order point is approached.

The latter orders material from the outside by requisition on the purchasing department or places orders in the shop for runs on the parts that are approaching this order point in time for them to arrive in stock before the order point is actually crossed in either store. Thus, the chief dispatcher checked by the balance clerk answers two of our four problems of routing production, when and how many.

The engineering department with charge of equipment, tools and design answers the other two problems, where and how.

Each new part that is to be added and each change that is contemplated in the accepted methods is considered in the nature of development, and as such is kept entirely separate from regular production as controlled by the chief dispatcher.

Part one of two parts; the second, dealing with production examples and the item of safety, will appear in an early issue.

All such changes and additions are worked out by the engineers, whether the plans originate in the engineering department or are suggested through any other department of the organization.

The first step after the suggestion has been made is to consider its effect on the completed product from a standpoint of future repair part orders. The next step is to design tools, fixtures and gages and to determine the effect of the change on regular production as pertains to routing through the machines, to manufacturing costs and to the advantages estimated. These data are put down in writing as a suggestion from the engineers, on a form designed for the purpose, and are then submitted to the management. In the event of rejection, the matter is dropped.

Assures Accurate Records

In the event of approval, the change, or innovation, or addition, is put into direct production by the engineering department which follows and supervises the first run of parts through all of the operations affected. The record of this run, with the kinks all ironed out, is then turned over to the chief dispatcher with the necessary information for the latter to revise his records for future orders.

In this plant the foreman has no need to neglect his regular duties, and our system calls for no additional clerks.

To begin with, the rough and the finished stores departments send copies of each receipt or withdrawal to the balance clerk. In addition, the time cards on which quantity through each operation are recorded come across his desk. The exact count of parts that pass inspection, and those that are rejected, is made by the inspection department and sent to the dispatcher and the balance clerk.

Should it occur, in the course of inspection, that a number of parts have to be rejected, but, in the opinion of the chief inspector, are capable of salvage, the fact is noted on his report and the chief dispatcher issues a repair order which goes through a salvage department in the same manner as a direct order goes through production. In the event that salvage is successful, the inspection department notes the fact to the chief dispitcher at the point, and when, the side-tracked parts again enter the production stream.

In order that we may be able to keep our stock in process to a desired minimum, we must know of the start of trouble very quickly and take prompt steps toward correction rather than replacement.

To this end, each department foreman has control of his own inspector, known as a floor inspector, whose duty it is to watch progress rather than to piece inspect, to check progressive tool conditions, to advise with the foreman, and, in short, to forestall trouble. He has no power for rejection or for stopping an operation.

There is a chief inspector, however, who answers to me personally, and has the power to stop work after he has notified the production foreman. At the same time, the chief dispatcher is notified so he can take steps to keep the finished stores supplied without delay.

In the majority of cases, the cause for rejection and delay can be traced directly to tool failure, either due to wear or to disaster. Therefore, to obviate putting a great deal of money into spare equipment with its heavy overhead interest charge, action on a broken tool must be extremely prompt.

To gain this point, we have one man who acts in the nature of a tie between the production and the tool department, which latter is under the engineers. This man finds when tools can be released to the best advantage and the length of time they can be held out of production. He then fits these facts to the available man hours in the tool room and keeps the foreman there advised so the latter can set his force to perform the necessary work at and within the allotted time before production must resume.

A point in procedure that must be watched on large quantity production of very small parts lies in the natural shrinking due to loss and defect. It is useless to try to eliminate all of this loss by inspection or count. It is our custom to actually issue from the stores an overage based in quantity on our past experience and to satisfy this overage, on our books, by issuing, through the inspection department, a rejection memorandum the same as for scrap. This memorandum is included with the weekly check-up of scrap and is added to the scrap report. We find this method to check the actual loss closely and to represent a much smaller outlay of money than would be required in men to prevent it.

The order point is the starting and stopping point and is held in deep respect for the sake of our field repair requirements. When an order point on any part is reached in either stores department, further issue to the shop is completely stopped until a release comes through from the chief dispatcher. This release must show that raw material has been ordered and is on the way to rough stores, or that a run of the parts is on its way to remove the shortage in finished stores.

Buying and Selling Plan

So much for procedure and production control as referred to the "when" and "how many" and the "where" and "how." Actual performance and improvement on performance can be assumed by no one but the foreman and his force of workers.

I want to tell you, in this connection, a few of our standards for performance. Beginning in the chief dispatcher's office, each department works on the basis that it purchases materials from the department preceding it and makes a sale of its product to the next department in line. Anything that can be done in any department to show a margin of profit between cost and purchase and sales receipts reacts to that department's credit.

Practically all of the work is done on guaranteed piece rates, in the setting of which it is a company policy to establish the rate for each job below a point where unusual effort is required to make the grade. In other words, we endeavor to set a rate that can be readily made by the average operator without fatigue. It has been found time and again that to require more defeats its own purpose.

It is another company policy that no reform in methods shall be imposed on any foreman. If a reform is proposed and is adjudged to be worthy of inauguration, it is led up to by assisting the foreman affected in every way to make the methods he is using at a given time go better and to show, if possible, the inadvisability of change. Oftentimes this is found to be possible. If it is not, however, the reform is proposed as the next step by way of further improvement. It is very seldom that such procedure does not meet with the foreman's approval and co-operation. A fair break between management, foremen and operators is our rule.

Details of Machining Operations in a British Railway Shop

By I. Wm. Chubb
Editor, European Edition, *American Machinist*

An unusual set-up—Boring and milling an awkward piece—Multiple boring—An assembly table—Cutting angular slots — Long overhang boring — Valve gear assembly — Multiple planing

THE Gresley 2–6–0 locomotives used on the London & North Eastern Ry. in Great Britain have triple cylinders 18½ in. in diameter and 26-in. stroke with 9¾-in. and 9¼-in. valve chambers. In the railway company's shops at North Road, Darlington, each of the cylinders, with its valve chest integral, is marked-off, planed and faced for fitting to the engine frame and drilled for the securing bolts. The three cylinder castings are then fastened together and the joints made, the single piece thus formed being mounted in a boring machine on a knee which represents the engine frame, the bolt holes previously mentioned being used for locating purposes. The six bores, one for each of the cylinders and valve chambers, are then machined simultaneously, two cuts being taken in each case. The time occupied from floor to floor is about 45 minutes for both handling and machining.

The saddle for the smokebox on the central cylinder is next bored in another machine and the method employed is illustrated in Fig. 1. The cutting tools are carried on what is essentially a wheel, rotating and sliding on a horizontal spindle, and the cylinder castings, one on each side, are placed on bases that insure correct curvature. The fixtures used represent the seatings of the cylinders in the frame, and the setting is obtained by means of locating pins through the cylinder flanges, while the actual diameter of the saddle bore is obtained from the boring head.

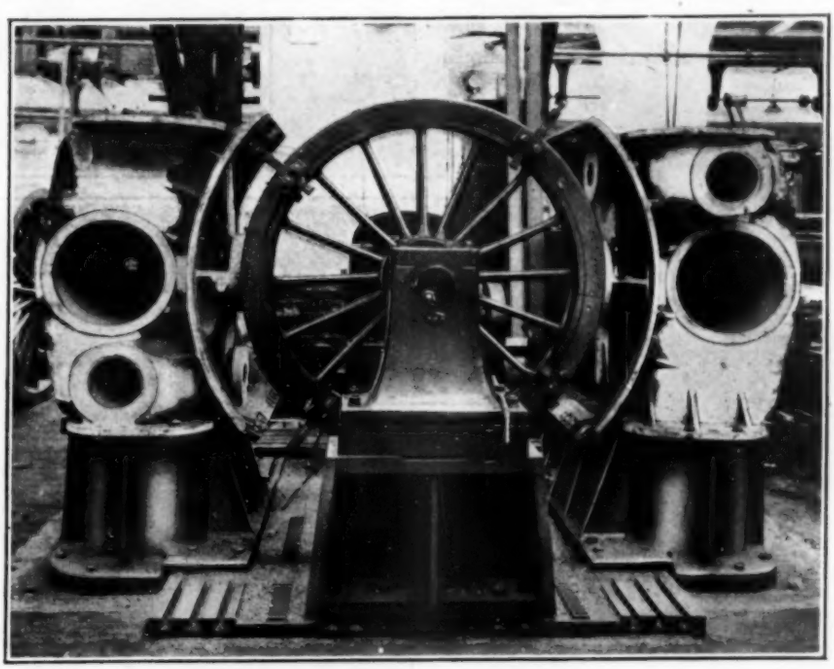
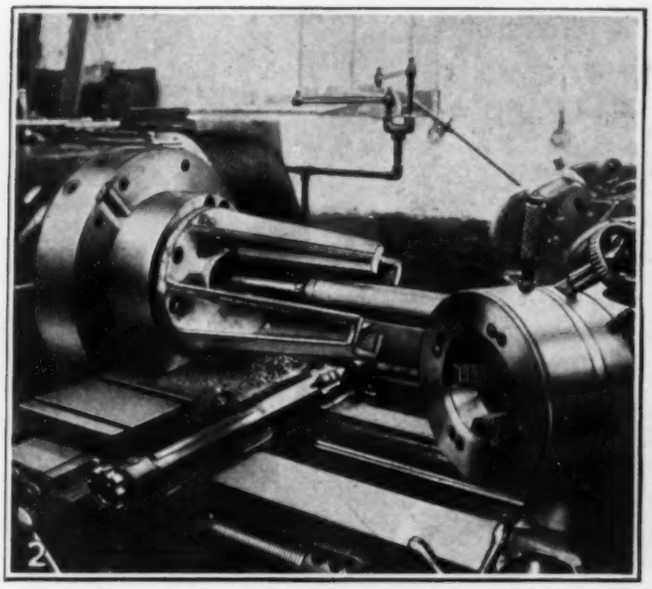


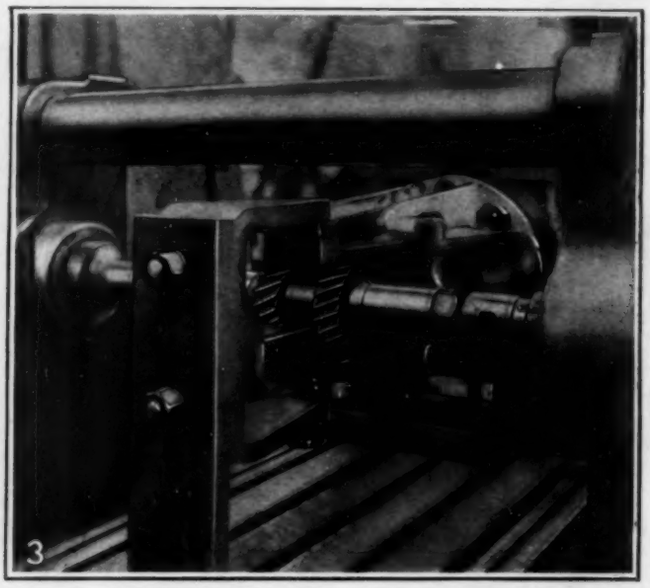
Fig. 1—Set-up for machining cylinders

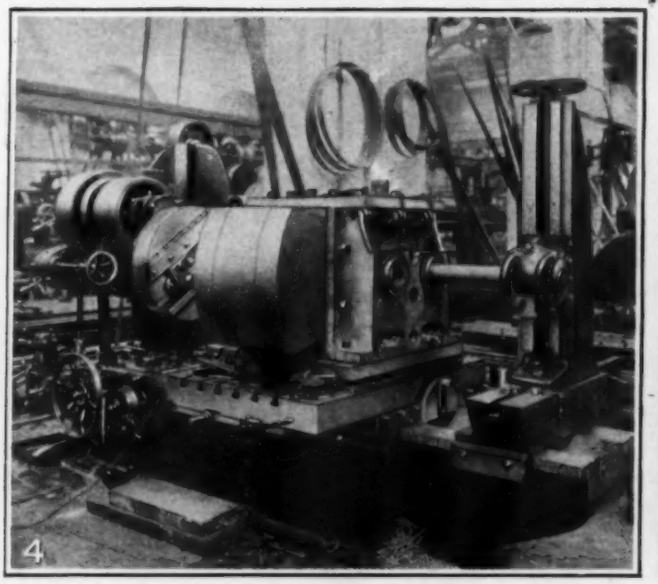
In Fig. 2 is illustrated the boring of stuffing boxes for the valve chest covers. This operation is done in a jig on a No. 20 Herbert combination lathe. The work is of awkward shape so that it is difficult to handle a number expeditiously. The cover face and spigot are therefore turned first, and drilled for assembly on the jig, to ensure concentricity of the stuffing box bore with the piston valve chamber. The boring bars used each contain three tools for the respective bores, namely, roughing bar, finishing bar, and facing bar, all the bars running in pilot bushes.

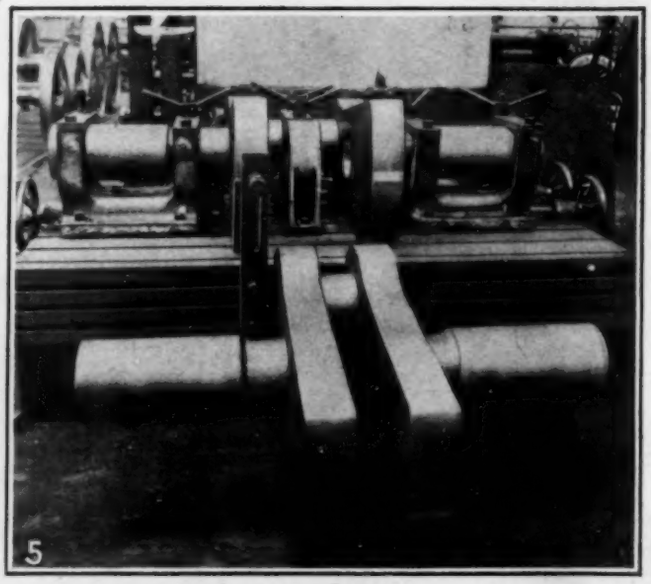
The method employed in milling the valve spindle guides is shown in Fig. 3. The attachment is used for all milling operations to take the crosshead, insuring alignment with the bore of the cover spigot. Locating stop gages eliminate any setting, the stops being lifted or lowered at will by means of a screw in the jig within the slide housing. The milling sequence is to slab-mill channels and the side faces along the base channels, then release the jig slide, lift to the stop and work from back to front on the top channel faces. The cutters are then placed, as shown in the illustration, for dealing with the guide slides. This cutting is done from the front to the back on the base, and from the back to the front on the top. The illustration shows an adjustable bracket which helps to prevent spring when the cutters are working from the front, holding the cover rigid throughout the operation.

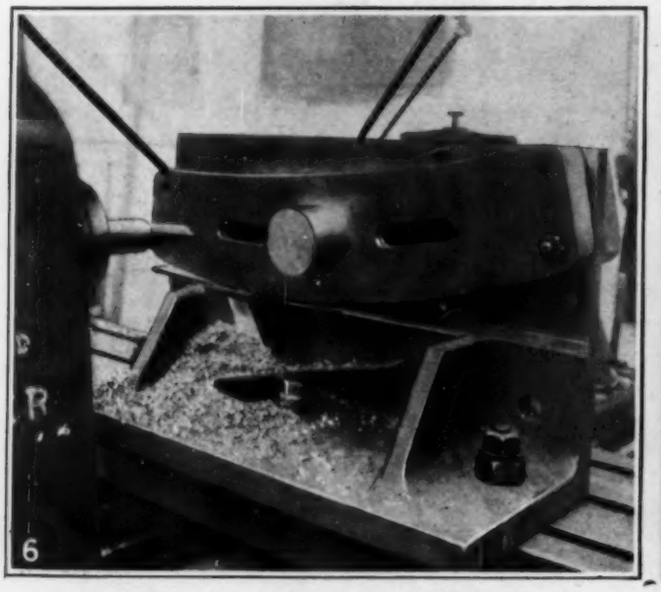
The jig used for boring crank webs is illustrated in Fig. 4. Four webs are dealt with at one setting. Wedges enable the operator to set each independently to correspond with a common center line. The end











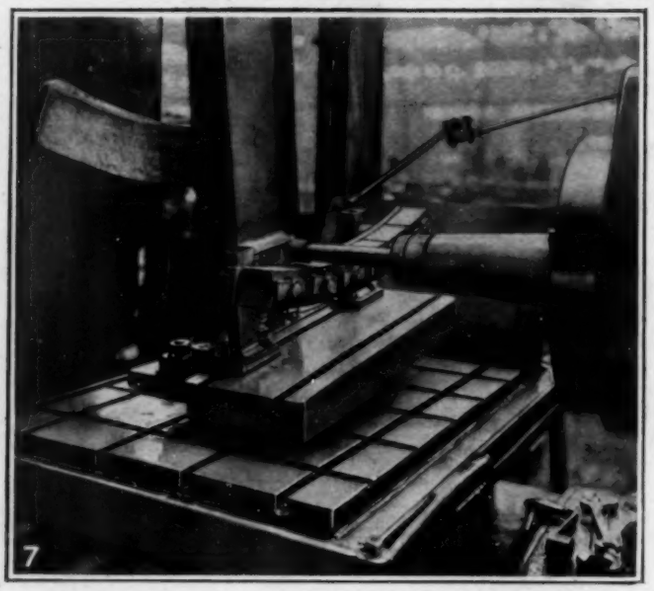


Fig. 2—Boring stuffing boxes. Fig. 3—Milling valve spindle guides. Fig. 4—Jig for boring crank webs
Fig. 5—Table for crankshaft assembly. Fig. 6—Set-up for slot-drilling links
Fig. 7—Grinding expansion blocks

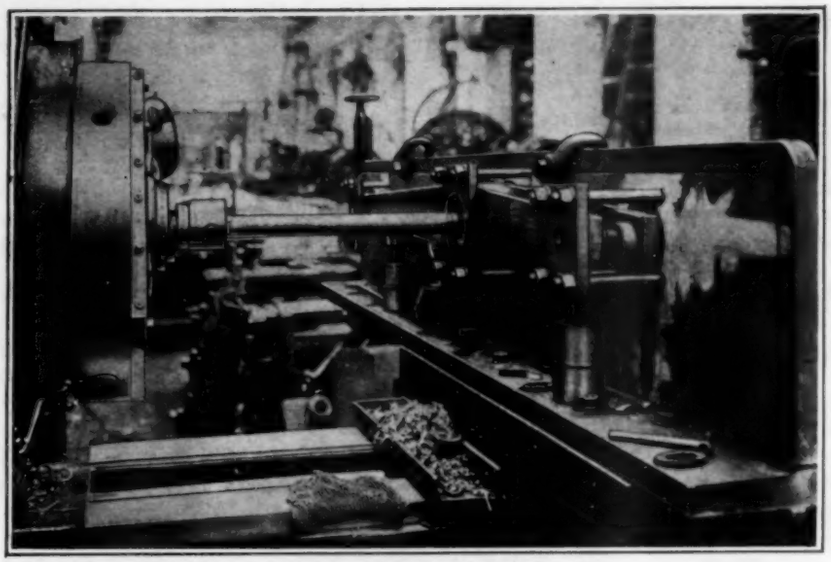


Fig. 8—Boring motion levers

frame plates of the jig have hardened bushes ground to size. The tools in the tool head are set from the front plate of the jig, which determines the bore size required in the webs. The work, as shown, is done in a Pearn-Richards universal machine.

A table specially designed for the assembly of built-up crankshafts is shown in Fig. 5. The components of the crank are fixed on V-slides and the web is located in position and then locally heated to the required temperature by a gas ring, the axle and pin being then moved on the slides into the web by handwheel and screw. Very little skill is required for the work as the device is practically self-setting and insures the necessary accuracy.

The method of slot-drilling side plates for expansion links is illustrated in Fig. 6, locating pins determining in change-over positions the correct angularity for the slots. The method of grinding expansion blocks is illustrated in Fig. 7, the jig holding six blocks which are ground simultaneously. These are of course fixed to a movable pendulum and set to the radius.

For boring the 2-to-1 motion levers the jig shown in Fig. 8 is used. This has to be of massive proportions, as some amount of overhang is necessary to enable the lever to be completed at one setting. The supports are adjustable from the main jig support in order to insure rigidity when machining the various bores. The center limits of the hole are determined from bores in the main jig. After the main bore has been finished to suit the ball race, the locating pin passes through the lever into the main jig after which the end holes are located by a bar through the jig, the table being traversed until the headstock is engaged. The levers are of nickel-chrome steel.

The assembly jig for the Walschaert valve gear shown in Fig. 9 consists of a dummy frame with fittings mounted on it, the object being to reproduce the finished engine frame. On these fittings the complete valve gear is assembled, the jig ensuring that all the gear units are in accurate alignment and are also alike, leaving only re-assembly necessary at the erecting pits.

For planing axle boxes, Fig. 10, the machine employed has two double spring-relief tool bars, each planing simultaneously at two sides a number of axle boxes to insure parallel sides. The tools are adjustable within limits by means of locking slides, each being independent for adjustment purposes. At the same time the tools in both the right and left side heads are used to plane the outside surfaces of the outer rows of boxes. This method insures parallelism of all side surfaces.

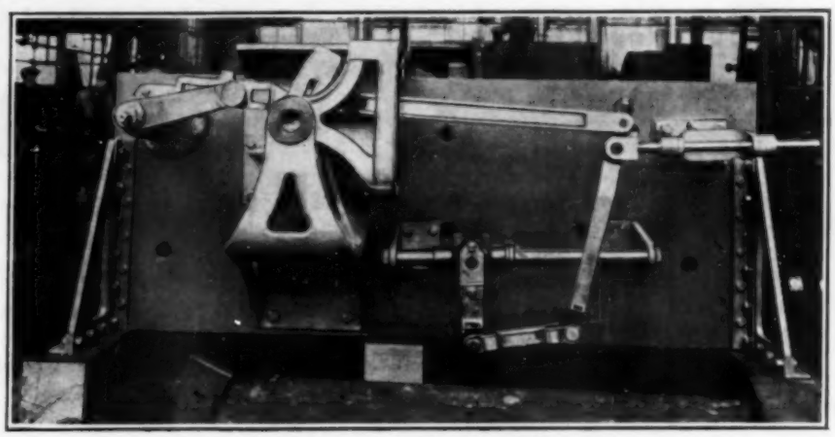


Fig. 9—Assembly jig for valve gear

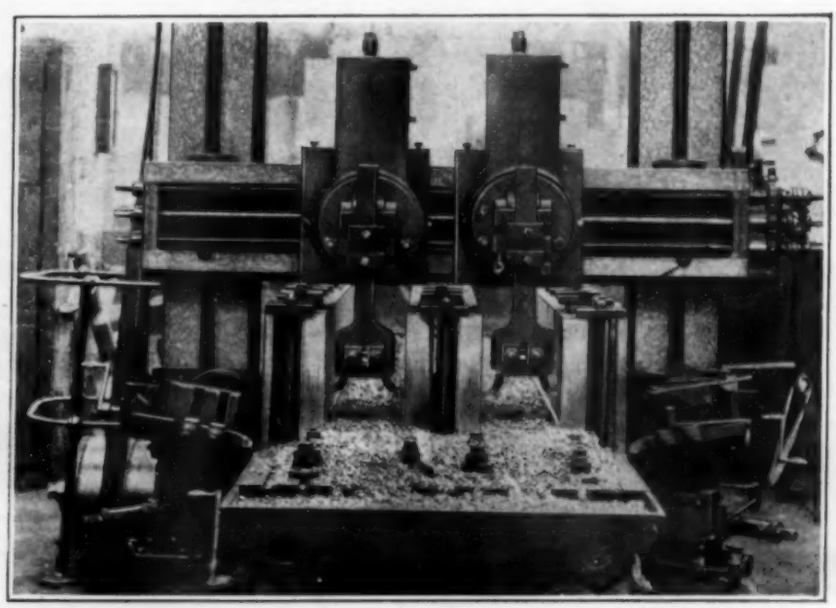


Fig. 10—Multiple planing of axle boxes

Jim Gets Over His Head

BY ENTROPY

Jim was over this morning. Talked about the weather, professional foot ball, the League of Nations, and so on until I asked him what he was leading up to. It finally came out that this efficiency man that I wrote about has got him for fair. Jim has always made money, more than he had any use for, but Jim's wife was never satisfied. Anyway it seems she got Jim all worked up about bigger business, and this efficiency man that needed a job was a cousin once removed, so naturally the fact that he needed something to do settled it.

What ails Jim is that this man has pointed out what everybody in town has known for years, that his shop is a sort of old men's home. Every old man that has been dropped from the other shops in town for the past ten years is drawing pay from Jim. Jim knew it just as well as the rest of us, but now he feels obliged to justify this crew to the man he has engaged to put him in line for bigger and better business. Not having given the matter any thought before, he came over to get me to do some thinking for him.

THE VIEWPOINT OF MATURITY

I asked Jim what age limit his man wanted to set. "About 40," he told me. Now Jim is about 60, and a man of 40 looks to him like a boy that may grow up and be credit to the shop, and yet is too young to be sure about. Of course this efficiency man thinks that every man that is a year older than he is has reached his second childhood.

Jim's idea about these old birds is that they work on the same piece rates as the younger fellows, and they don't need so much money, so they take it easy, and only get what they earn. He didn't see any reason for fussing about it. Couldn't expect the young fellows to take any lower rates and stay, and the old men turned out enough production, anyway.

Then I got him to give me some figures on a job that he runs year after year, one that he really knew about. Here are his figures:

Young man makes 10 pieces per day at 60c.	$6.00
Overhead charges, 200 per cent	12.00
Total	$18.00
Old man makes 6 pieces per day at 60c.	$3.60
Overhead charges, 200 per cent	7.20

And right there I stopped him. "The trouble with you is that you have a habit of treating overhead as purely a percentage of direct labor. You forget that your overhead goes on no matter how much or how little a man does. You ought to charge overhead by the hour. Now take the young man with $12.00 charged up to overhead. He works four-fifths of an hour on each piece so that overhead rate is the same as $1.50 per hour. Your old man uses an hour and twenty minutes to do the job, in comparison, so the overhead for him ought to be $2.00. So you cannot afford to pay him anything for working, in fact you ought to make him pay you 20 cents for the privilege of belonging to your club."

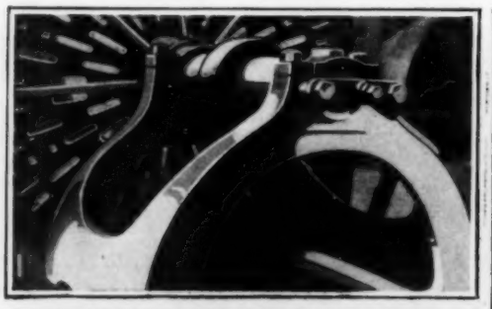
Jim didn't see it, but he took the figures back to his own shop to chew them over.

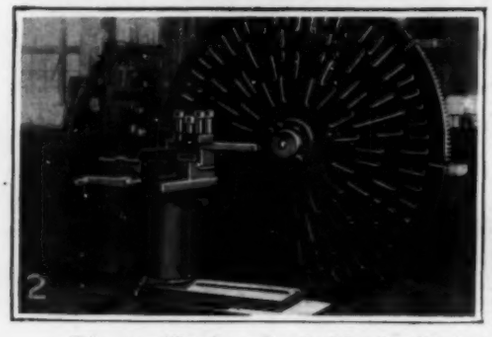
Changes in Wheel-Lathe Design

Judging by some of the wheel lathes still in use, a few of the first vintage are still keeping away from either the scrap pile or the museum.

The old wheel lathe shown in Figs. 1 and 2 is still doing time in a railroad shop that shall be nameless, although it is difficult to imagine that it can be rendering service commensurate with the shop space it occupies. It is necessary only to note the design of the headstock in Fig. 1, and of the toolpost in Fig. 2, to get an idea of the general unsteadiness, and of the vibration that must take place when the machine is in use.

In contrast with the old lathe, we show a wheel lathe of modern design. Designers will instinctively compare the amount of metal in the headstocks of the two lathes, likewise the tool supports and clamping devices. The contrast speaks volumes for the advances in machine-tool design and makes it evident that there can be no comparison in the cost of work done.





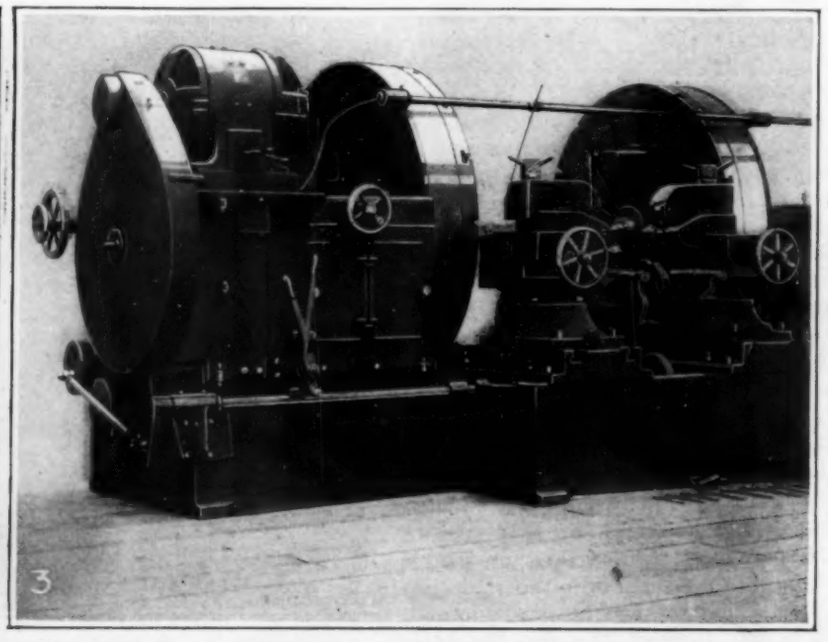
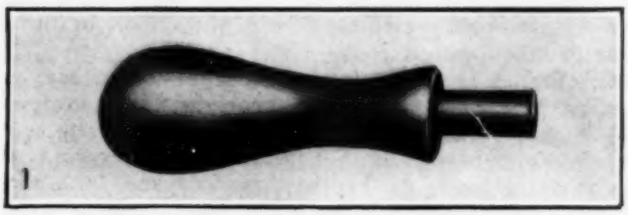


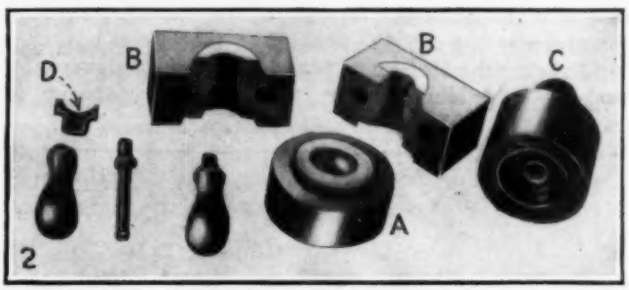
Fig. 1—Headstock of old wheel lathe. Fig. 2—Tool post and faceplate. Fig. 3—A modern wheel lathe

Drawn Shells Reduce Machining Costs

By Ellsworth Sheldon
New England Editor, *American Machinist*

Drawing steel of unusual thickness—Metal is thinned or thickened locally as required—A pipe union made of drawn steel shells—Closing in, or necking, operations





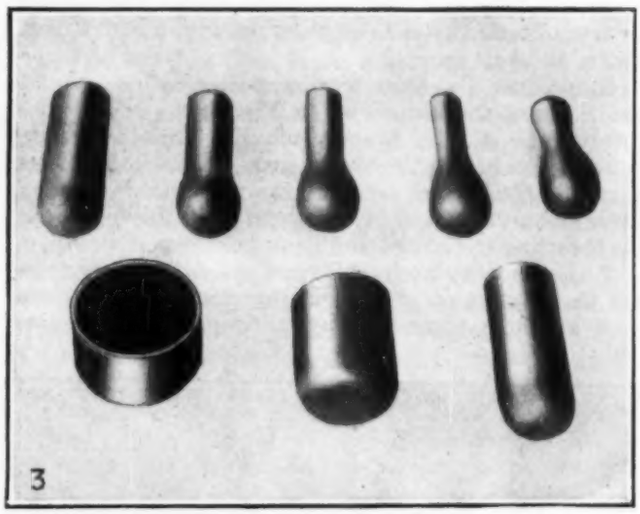


Fig. 1—Handle for handwheel, with loose spindle. Fig. 2—Components of the handle and the final tools Fig. 3—Sequence of operations on outer shell

MANY small machine parts that are usually cast or made from bar stock and turned out on the lathe or automatic screw machine can, if one possesses a practical knowledge of the processes involved and a determination to put the job through, be made of sheet metal by way of the drawing press; effecting thereby a distinct saving in cost of material and labor. Further advantages lie in lessened weight of the parts (when lightness is an advantage), in more uniform and homogeneous material, in appreciable reduction in the percentage of rejection and almost complete absence of waste, and last but not least the ease with which uniformity of product may be maintained.

While the initial cost of tooling is likely to be high when compared with the cost of tooling for a similar product in lathe or screw machine, the tool maintenance cost as checked against the output is very small indeed; leading at once to the conclusion that to render the press drawing method economically applicable to the work in hand the number of pieces required should be large. Handling costs are greater by the press method, for there are more operations, but supervisory costs are comparatively low, and every piece may be depended upon to be like every other piece.

Few machine tools are complete without one or more, sometimes many, of the small handles shown in Fig. 1.

Photographs and data by courtesy of the Rockwood Sprinkler Co., Worcester, Massachusetts. The parts shown are patented.

Many one-piece handles of this kind are made from bar stock on a screw machine or lathe, requiring broad forming tools that operate slowly and demand much attention. This one happens to be a three-piece handle, patented by its makers and known by the trade name of "Quick Action," having a central spindle upon which it takes a bearing. The same tools are used, however, to make one-piece handles up to the point of final operation.

The spindle of this part is not a shell, though it is made upon a press and requires no other machining operations. The outer shell—which is the handle—is produced upon a drawing press in eight operations. The small shell that forms the bearing for the inner end of the spindle is made in three operations. The spindle itself is a piece of cold-rolled steel that is subjected to an upsetting operation in a press to produce the small shoulder necessary to hold it in the shell. All three parts are shown in Fig. 2, which also shows the tools for the final operation.

In Fig. 3 is shown the sequence of operations upon the outer shell up to the point of closing it upon the spindle. The material is hot-welded steel, ranging in thickness from 0.062 to 0.100-in. according to the size of handle to be produced. The first operation is performed on a double-action press and produces the cup shown at the left of the bottom row. The next three are simple push-through redrawing operations, the tools

for which are inexpensive to make and are capable of producing many thousands of pieces.

Beginning with the fifth piece shown in Fig. 3 the work consists of closing in, or "necking," the upper end of the shell, which results in a gradual thickening of the metal. The tools for these operations consist of round dies shaped to conform to the shells as shown in Fig. 3, and punches that are hollowed out to enclose the shells down to the point of largest diameter. A knockout is necessary to eject the shells from the dies.

All of the foregoing tools can be made in a lathe and involve no difficult problems other than knowing just how far a shell may be drawn without splitting or closed in without buckling—always a matter of experiment on a new shape. The remaining operations require somewhat more complicated tools, as the metal at the open end must first be re-expanded and then closed in to retain the spindle, which is put into the shell just before the final operation.

To produce the flare at the smaller end, shown at the right of the upper row in Fig. 3, the shell is set into the die *A*, Fig. 2, and confined by the blocks *BB*, which slide in the die-holder and are closed by cams carried by the punch-holder. The punch *C*, descending upon the exposed end of the shell, causes it to expand by upsetting it rather than by swaging it outward.

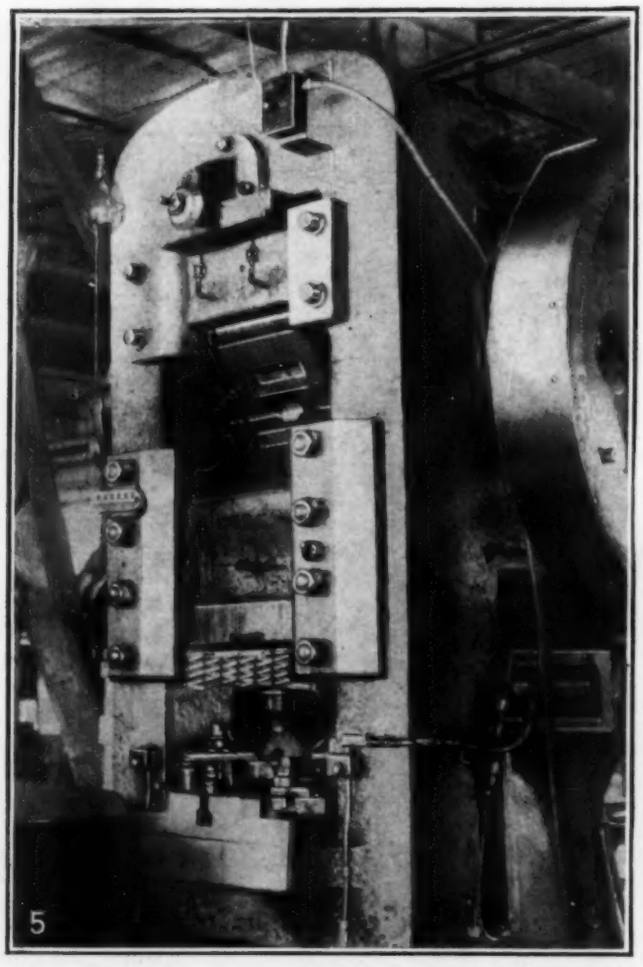
To prevent the blocks *BB* from springing away from the shell by reason of the heavy pressure that tends to separate them, there is an upwardly projecting boss on each that, when the blocks are closed together, form a circular projection to enter and be confined by the recess in the punch.

The small shell *D* is forced into the outer shell after the fourth operation upon the latter. This shell is made in three ordinary drawing operations and is, of course, circular. The part as shown in the illustration has been split to show its section. The reduction in diameter of the outer shell, beginning with the fifth operation, effectively prevents the small shell from being displaced. Its purpose is to form the bearing for the end of the central spindle.

The final operation is performed in the same dies as shown in Fig. 2 but with a different punch. Its object is to fold the wall of the shell inward so that it encloses the shoulder of the spindle. The handle is completed by this operation and is ready to be put into service by pressing the exposed shoulder of the spindle into the rim of a handwheel.

In Fig. 4 is shown the sequence of operations in making the male end of a composite union to join 1½-in. pipe. This is also a press job, the opposite end of the union as well as the ring nut that joins the two parts being made in the same manner and from the same material, which is hot-rolled deep drawing strip steel of 0.187-in. gage. Except for the necessary threads the union is entirely the product of the press.

Though a double-action press is required to make the first cup, the blank holder in its ordinary capacity is



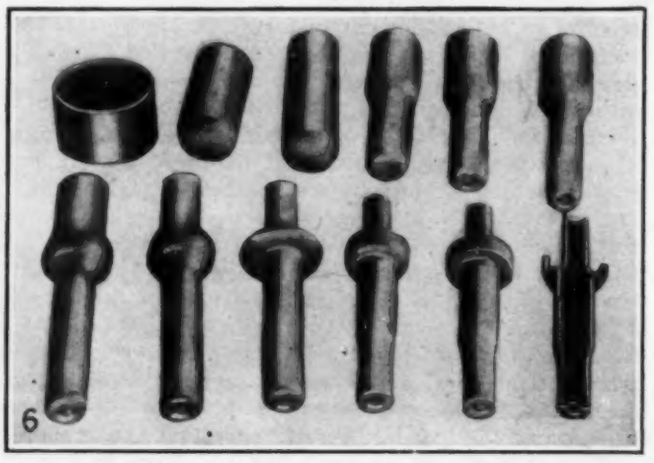


Fig. 4—One part of a sheet metal pipe union. Fig. 5—One of the heavy coining presses. Fig. 6—A shell that replaces a casting

not needed. The blank holder slide of the press carries an annular punch to blank out the disk from the strip stock, and the disk is immediately forced into what is in effect a forming die by the drawing punch.

The second operation is a simple push-through redraw, performed by ordinary round parallel tools. The third, fourth and fifth operations require formed dies and punches to suit the contour of the shell, and a knockout is necessary in each case to eject the shell from the die. Between the fifth and sixth operations as here shown the bottom of the shell is pierced out to the full size of the inner diameter to leave the run of the pipe free.

An Upsetting Operation

The final operation is to form the hexagon shape on the body of the shell so that it may be screwed into a fitting by means of a wrench. For this work a very heavy coining press of the type shown in Fig. 5 is used. As may be seen in the illustration, the punch enters the shell but a short distance, the pressure being delivered mainly by the shoulder of the punch, which forces the metal into the hexagon-shaped cavity between the walls of the tools. This operation is rather one of upsetting than of drawing.

Another part that is now made of sheet steel to take the place of a casting is shown in Fig. 6, wherein the two pieces at the right of the lower row represent the finished part. When made of cast iron these parts require a deal of machining to fit them to their purpose, not the least of the machining operations being the drilling of the hole nearly through the piece lengthwise and forming a bearing at the bottom of it for a revolving spindle.

The product of the draw press requires practically no machining operations. The hole is already in it, and though the shell is chambered out, unlike the drilled hole in the casting, the chamber is a distinct advantage as a reservoir for oil.

To all who are familiar with press drawing operations the story is practically told by the illustration. The stock to begin with is 0.1-in. gage hot-rolled steel, but it is thinned down to half that thickness over the lower end of the shell by the drawing operations and increased to more than twice the original thickness by the necking operations at the other end.

Forming the Cup

The part in service carries a rapidly revolving spindle that takes its principal bearing in the thickened upper portion of the shell but is steadied at the lower end by a step bearing that may be seen in the split shell. The latter bearing is formed in the fifth and sixth operations by the shaped ends of the punch and knockout.

The bulge that is eventually to form the cup is started at the seventh operation and is produced by endwise pressure upon the shell, causing it to upset at the place where it is not confined by the tools. In the tenth operation the flattened bulge is pushed into a drawing die and the cup formed of the double thickness of metal exactly as if it were single.

The eleventh operation is the most exacting of the sequence, as in it the shell is confined at all points between the walls of the die and punch and there must be exactly the right quantity of metal in the shell to fill the space. Too little metal would result in a shell incompletely formed at the corners, and too much would jam the press.

Seen and Heard

By John R. Godfrey

Bearings and Lubrication

WHEN a man begins to tell me all about lubrication and bearings, and lays down the law on bearing areas, pressures, oil viscosity, etc., etc., I begin to wonder if he really knows any more about that than I do—and that's mighty little.

I've seen a lot of bearings, from the old apple-wood blocks on a line shaft that had run ever since the old shop was built and that no one ever oiled except by mistake, to the high speed, ball-bearing machines that count their r.p.ms. by thousands. But when it comes to knowing just why one runs cool and another runs hot, I'm still far from being a Newton or a Burbank. Of course, there are laws that govern bearings as well as everything else, only we seem to have been most successful in letting them elude us so far.

I've seen bearings run hot without apparent reason and others where projected area was almost a minus quantity, run perfectly cool. Yet when the bearing area was increased, the same bearing ran hot. I don't think there is any mystery about it—merely that there are probably lubrication factors that offset some of the others, and about which we know very little.

One of the neglected features of lubrication, or the lack of it, is that of the wear of parts, rather than friction or of the cost of lubrication. I heard an oil man discourse for an hour the other day on the great loss of power because of using oil of the wrong viscosity and of not having proper lubricating devices. The total of coal consumption that is lost in friction would keep many thousand families warm all winter.

But he never mentioned the cost of repairs to machines that are insufficiently lubricated, or the delays to production when they are laid up for overhauling. Of course, there is a lot of oil wasted in all machine shops and on railways, but it's a mighty ticklish place to try and save money. About twenty-five or thirty years ago the railroads had a spasm of oil economy and sewed themselves up with oil contracts to cover all the oil for locomotives. Experts determined how many drops of cylinder oil you could feed a consolidation locomotive to pull a string of freight cars, and they made a great showing on the saving of oil. The roads measured it by the teaspoon and allotted it to the engineers as though it were gold dust.

They saved money on oil and lost it on train delays, burnt-out bearings, piston-ring and cylinder wear, and in a dozen other places. As a railway-shop man told me at the time, it cost ten dollars in repairs for every dollar saved in oil. But they didn't charge repairs into the oil bill, as they should in many cases.

Oil is an important item—the main thing is to have enough, but not too much, on bearings where an excess causes trouble. On plain bearings it is best to err on the safe side. And when anyone finds out a real rule about bearings I'm all interest.

Steam hammers are rated by the weight of the hammer head alone, the same as a drop hammer. Neither the steam pressure nor the length of stroke is counted where figuring the rating.

Wanted—A Time-Saving Scale —Discussion

By Donald A. Hampson

IT HAS been said of congressmen that if they receive one letter from a constituent they pay no more attention to it than to have the secretary send a stereotyped reply, because they figure that there is always one person out of a thousand who will peep, anyway, but if they receive two, three, or more letters upon a subject they sit up and give that subject serious consideration, because they know it is arousing the spirit of the people back home to an extent that may swing a thousand votes for every letter received. Since my original letter under the title given above was published on page 996, Vol. 62 of the *American Machinist*, others have appeared, proving that it is a subject close to the work of all machinists.

One manufacturer has gone so far as to make up a few rules that are graduated upon more modern lines. These rules have two edges graduated in sixteenths and two in thirty-seconds. Every edge is thus a useful edge, and a workman can make but one wrong move in placing such a rule against his work.

Convenience of Position

Where a man is doing repetition work all day long, as at a lathe, it is possible for him to keep a rule lying in front of him all the time—and he can always pick it up with the graduation he has to use in the position he wants it to be—but most men have to do a certain amount of shifting, and of necessity they must put their rules in their pockets. In the latter case, the chances are three to one against taking the rule out right side up and so a rule made as referred to is three times as convenient as the standard rule.

Another manufacturer has written to say that he believes a rule of greater convenience would be a distinct improvement, but doubts if it would sell readily under existing merchandizing arrangements. He is referring to the hardware trade, which is the chief retail outlet, where neither the buyers nor the clerks have a knowledge of machine-shop needs, hence they continue to order rules from the present eight numbers of listed graduations, awkward though they may be. Machinists take them off their hands, chiefly because any protests they may make are met with a display of toolmakers' catalogs showing that there are no other graduations to be had.

It is unfortunate that mechanics' tools are retailed through such uninformed channels. A few days ago a road man needed a ¼-28 tap, and stepped into a big modern hardware store, replete with the most up-to-date show cases and other display equipment. The clerk evidently knew the stock, which was large, but finally reported that they were all out of "one quarter twenty-eights" but that they had thirties and thirty-twos that "probably would answer the purpose." So long as this (common) condition exists, rules of improved style, and other tools brought up to the minute, are at a disadvantage.

One of your correspondents speaks of working with the sixty-fourth graduations all day, and innocently mentions that he has a cataract forming on one eye. Sixty-fourths are too fine to be seen in average-shop light, and few men of normal vision can be depended upon to work accurately to them in the best of light. If the rules are graduated with hair lines, a magnifiying glass must be used, as is done with surveying instruments, to be sure of the lines, and if the graduations are heavy, they occupy so much width that a few seconds of steady gazing runs the lines into a blur.

One thing that works against the accuracy of measurement with ordinary steel rules, is the way they are used. They are generally placed flat against the work—because most lighting schemes show up the graduations better that way—and in that position the effect of parallax may easily throw the reading a sixty-fourth off. Therefore, the chances of reading sixty-fourths accurately by splitting spaces on thirty-second graduations are as good as when trying to read from the sixty-fourth side.

The thin, flexible steel rule is proof against the errors of parallax but it does not find favor for general use, because the flexibility diminishes its usefulness as a straight-edge.

Graduations may be made of greater visibility by sharp contrast in the lengths of lines. If the least-count lines are made ⅛ in., or less, there is a chance to step up the succeeding divisions by very appreciable amounts. According to the graduations, there are always from two to five division lines longer than the shortest. If they are very nearly of the same length, there is presented a jumble of lines hard to pick out, but if the rule is graduated with big steps between different lengths, the eye instantly selects the ones needed.

The Groove of Standardization

By William F. Sandmann

"That's our standard, and so we will just stick to it." That is the approximate wording of one of the common excuses in use today to "get around" the purchase of new machine tool equipment.

Almost everybody who uses machine tools or keeps an executive eye on their operation has heard that excuse. True enough, it is an excuse with many advantages. You are on the safe side and you are staying there. You are taking no chances, even if you are losing profits.

Everywhere we hear that this is the age of standardization. But, the same as everything else, there is a limit to standardization, and when you reach that limit you are in the "groove." Simply because a manufacturer finds that a certain type and make of machine tool is satisfactory in his plant is not a reason for him to forget that other concerns are building similar types of tools. One of these other builders is sometime going to have a tool to offer that has advantages over his old standard. If the manufacturer is not in touch with these new developments he does not know when he has reached his "groove," and is running along in it backwards.

So it is a dollar and cents proposition for every plant executive to stop and consider if the "standards" he has stood by so long are still the best. How about the dozens of advertisers of similar machine tools who are annually spending thousands of dollars in their endeavor to get you to ask about their product and what it would do for your plant? No matter if your shop is full of seemingly peerless machine tools, don't get so far in the groove that you can't switch out when a better tool is offered to you.

The Design of Gear Tooth Forms

By Earle Buckingham
Associate Professor of Engineering Standards and Measurements
Massachusetts Institute of Technology

Smooth gear action possible with various combinations of range milling cutters by correcting depth of tooth — Compensation for backlash

IT HAS been customary to cut a gear with a cutter corresponding to a smaller tooth number, if no exact tooth number cutter is available. Many drives, however, can be greatly improved by using on one gear a cutter which corresponds to a larger tooth number, while the other gear is cut with the usual cutter.

The following simple equations must be solved to obtain these results:

When n = number of teeth in pinion
n' = exact tooth number of cutter for pinion
d = difference in tooth number for pinion, or $(n - n')$
N = number of teeth in gear
N' = exact tooth number of cutter for gear
D = difference in tooth number for gear, or $(N - N')$
D' = drop in velocity ratio during mesh
b = excess depth to cut teeth for tooth number compensation
B = excess depth to give desired backlash
B' = total excess depth to cut teeth.

Then
$$D' = \frac{D}{N \times N'} + \frac{d}{n \times n'} \qquad (67)$$

When n' or N' is larger than N or N respectively, the values of d or D will be negative. If the cutters are selected, one of larger tooth number and the other of smaller, so that equation (67) becomes equal to zero, true uniform motion gears will be realized. The value of this equation should be kept as small as possible, and always positive. Negative values must be avoided. Preferably the smaller gear is milled with the cutter which corresponds to a larger tooth number. Equation (67) must be solved first to insure that a proper selection of cutters has been made. If the value is negative, or if it is large, another selection of cutters should be made.

The following equations are based on 14½-deg. gears of 1 diametral pitch. For other diametral pitches, the results are divided by the required diametral pitch.

$$b = 0.2n' \left(\frac{D}{N \times N'} - \frac{d}{n \times n'} \right) \qquad (68)$$

The value of b may be positive or negative. If the value of b is negative, it would mean that the pinion should be cut that amount shallower than standard. In these equations, the term "pinion" always refers to the driving gear, which is usually the smaller of the pair.

$$B = 2 \times \text{desired backlash} \qquad (69)$$

The eleventh article. The twelfth will appear in an early issue.

The total excess depths to cut the gears, with due allowance for backlash and compensation for the cutters used, are given in the following equations:

For pinion n:
$$B' = B - (B - b) \frac{N'}{N' + n'} \qquad (70)$$

For gear N:
$$B' = (B - b) \frac{N'}{N' + n'} \qquad (71)$$

Equations (70) and (71) for the excess depths may be used, as long as both excess depths are positive; as noted before, b itself may be positive or negative.

For convenience, we will again list the series of eight range cutters with their exact tooth numbers.

Number of cutter	Exact tooth number	Number of cutter	Exact tooth number
1	135	5	21
2	55	6	17
3	35	7	14
4	26	8	12

As an example we will take a 16-tooth pinion driving a 29-tooth gear, 6 diametral pitch, to run with 0.010 in. backlash. This backlash would correspond to six times as much on a 1 D.P. gear, or 0.060 in. We will use a No. 6 cutter for the pinion and a No. 4 cutter for the gear. Thus we have

n = 16 teeth
n' = 17 "
d = −1 "
N = 29 "
N' = 26 "
D = 3 "

From equation (67) we get

$$D' = \frac{3}{29 \times 26} - \frac{1}{16 \times 17} = +0.000303$$

This value is small and positive, and is therefore satisfactory. This value is so near to zero that practically perfect action will be secured between the gear teeth.

From equation (68) we get

$$b = 0.2 \times 17 \left(\frac{3}{29 \times 26} + \frac{1}{16 \times 17} \right) = 0.0260 \text{ in.}$$

From equation (69) we get.

$$B = 2 \times 0.060 = 0.120 \text{ in.}$$

From equation (70) we get for the excess depth to cut the 16-tooth pinion

$$B' = 0.120 - \left(0.120 - 0.02603 \right) \frac{26}{26 + 17} = 0.0632 \text{ in.}$$

Reduced to 6 D.P. this excess depth becomes 0.0105 in.

From equation (71) we get for the excess depth to cut the 29-tooth gear

$$B' = \left(0.120 - 0.0260 \right) \frac{26}{26 + 17} = 0.0568 \text{ in.}$$

Table IV—Corrected Tooth Depth with Various Combinations of Range Milling Cutters 1 D. P. Gears

No. of Teeth in Gear		Number of Teeth in Pinion								
		12	13	14	15	16	17	18	19	20
		Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.
12	Pinion	8 2.1870								
	Gear	8 2.1870								
13	Pinion	8 2.1947	8 2.1870							
	Gear	8 2.1793	8 2.1870							
14	Pinion	8 2.1847	8 2.1764	7 2.1870						
	Gear	7 2.1893	7 2.1976	7 2.1870						
15	Pinion	8 2.1901	8 2.1818	7 2.1937	7 2.1870					
	Gear	7 2.1839	7 2.1922	7 2.1803	7 2.1870					
16	Pinion	8 2.1950	7 2.2062	7 2.1995	7 2.1928	7 2.1870				
	Gear	7 2.1790	7 2.1688	7 2.1745	7 2.1812	7 2.1870				
17	Pinion	8 2.1818	8 2.1728	7 2.1819	7 2.1768	7 2.1704	6 2.1870			
	Gear	6 2.1922	6 2.2012	6 2.1921	6 2.1972	6 2.2036	6 2.1870			
18	Pinion	8 2.1864	8 2.1774	7 2.1873	7 2.1817	7 2.1809	6 2.1925	6 2.1870		
	Gear	6 2.1876	6 2.1966	6 2.1867	6 2.1923	6 2.1931	6 2.1815	6 2.1870		
19	Pinion	8 2.1906	7 2.2014	7 2.1920	7 2.1848	6 2.2037	6 2.1975	6 2.1919	6 2.1870	
	Gear	6 2.1834	6 2.1726	6 2.1820	6 2.1892	6 2.1703	6 2.1765	6 2.1821	6 2.1870	
20	Pinion	8 2.1943	7 2.2055	7 2.1963	6 2.2153	6 2.2082	6 2.2020	6 2.1732	6 2.1683	6 2.1870
	Gear	6 2.1797	6 2.1685	6 2.1777	6 2.1587	6 2.1658	6 2.1720	5 2.2008	5 2.2057	6 2.1870
21	Pinion	8 2.1788	8 2.1690	7 2.1810	7 2.1730	7 2.1660	6 2.1838	6 2.1777	6 2.1722	6 2.1673
	Gear	5 2.1952	5 2.2050	5 2.1930	5 2.2010	5 2.2080	5 2.1902	5 2.1963	5 2.2018	5 2.2067
22	Pinion	8 2.1821	8 2.1723	7 2.1846	7 2.1766	7 2.1696	6 2.1879	6 2.1817	6 2.1763	6 2.1714
	Gear	5 2.1919	5 2.2017	5 2.1894	5 2.1974	5 2.2044	5 2.1861	5 2.1923	5 2.1977	5 2.2026
23	Pinion	8 2.1851	8 2.1754	7 2.1880	7 2.1800	6 2.1985	6 2.1916	6 2.1855	6 2.1800	5 2.2007
	Gear	5 2.1889	5 2.1986	5 2.1860	5 2.1940	5 2.1755	5 2.1824	5 2.1885	5 2.1940	5 2.1733
24	Pinion	8 2.1879	7 2.1995	7 2.1910	7 2.1830	6 2.2020	6 2.1950	6 2.1889	5 2.2100	5 2.2045
	Gear	5 2.1861	5 2.1745	5 2.1830	5 2.1910	5 2.1720	5 2.1790	5 2.1851	5 2.1640	5 2.1695
25	Pinion	8 2.1905	7 2.2024	7 2.1938	7 2.1666	6 2.2051	6 2.1982	6 2.1686	5 2.2135	5 2.2080
	Gear	5 2.1835	5 2.1716	5 2.1802	4 2.2074	5 2.1689	5 2.1758	4 2.2054	5 2.1605	5 2.1660
26	Pinion	8 2.1759	8 2.1644	7 2.1780	7 2.1694	7 2.1617	6 2.1790	6 2.1719	6 2.1649	6 2.1599
	Gear	4 2.1981	4 2.2086	4 2.1960	4 2.2046	4 2.2123	4 2.1950	4 2.2021	4 2.2091	4 2.2141
27	Pinion	8 2.1783	8 2.1677	7 2.1806	7 2.1719	7 2.1643	6 2.1820	6 2.1750	6 2.1680	6 2.1630
	Gear	4 2.1957	4 2.2063	4 2.1934	4 2.2021	4 2.2097	4 2.1920	4 2.1990	4 2.2060	4 2.2110
28	Pinion	8 2.1805	8 2.1699	7 2.1830	7 2.1744	7 2.1668	6 2.1849	6 2.1778	6 2.1709	5 2.1957
	Gear	4 2.1935	4 2.2041	4 2.1910	4 2.1996	4 2.2072	4 2.1891	4 2.1962	4 2.2031	4 2.1783
29	Pinion	8 2.1825	8 2.1720	7 2.1852	7 2.1766	6 2.1954	6 2.1875	6 2.1805	6 2.1736	5 2.1986
	Gear	4 2.1915	4 2.2020	4 2.1888	4 2.1974	4 2.1668	4 2.1865	4 2.1935	4 2.2004	4 2.1754
30	Pinion	8 2.1844	7 2.1966	7 2.1874	7 2.1786	6 2.1979	6 2.1900	6 2.1829	5 2.2074	5 2.2012
	Gear	4 2.1896	4 2.1774	4 2.1866	4 2.1954	4 2.1761	4 2.1840	4 2.1911	4 2.1666	4 2.1728
31	Pinion	8 2.1861	7 2.1985	7 2.1893	7 2.1806	6 2.2003	6 2.1923	6 2.1853	5 2.2099	5 2.2037
	Gear	4 2.1879	4 2.1755	4 2.1847	4 2.1934	4 2.1737	4 2.1817	4 2.1887	4 2.1641	4 2.1703
32	Pinion	8 2.1878	7 2.2004	7 2.1911	7 2.1825	6 2.2024	6 2.1945	6 2.1630	5 2.2122	5 2.2061
	Gear	4 2.1862	4 2.1736	4 2.1829	4 2.1915	4 2.1716	4 2.1795	3 2.2110	4 2.1618	4 2.1679
33	Pinion	8 2.1894	7 2.2021	7 2.1928	6 2.2136	6 2.2044	6 2.1965	6 2.1652	5 2.2144	5 2.2083
	Gear	4 2.1846	4 2.1719	4 2.1812	4 2.1604	4 2.1696	4 2.1775	3 2.2088	4 2.1596	4 2.1657
34	Pinion	8 2.1908	7 2.2037	7 2.1944	6 2.2154	6 2.2063	6 2.1985	6 2.1672	5 2.2165	5 2.2104
	Gear	4 2.1832	4 2.1703	4 2.1796	4 2.1586	4 2.1677	4 2.1755	3 2.2068	4 2.1575	4 2.1636
35	Pinion	8 2.1723	8 2.1608	7 2.1741	7 2.1646	7 2.1570	6 2.1766	6 2.1691	6 2.1624	6 2.1570
	Gear	3 2.2017	3 2.2132	3 2.1999	3 2.2094	3 2.2170	3 2.1974	3 2.2049	3 2.2116	3 2.2170

Table IV (Continued)—Corrected Tooth Depth with Various Combinations of Range Milling Cutters—1 D. P. Gears

No. of Teeth in Gear		Number of Teeth in Pinion																	
		12		13		14		15		16		17		18		19		20	
		Cutter No.	Corrected Depth, In.	Cutter No.	Corrected Depth, In.	Cutter No.	Corrected Depth, In.	Cutter No.	Corrected Depth, In.	Cutter No.	Corrected Depth, In.	Cutter No.	Corrected Depth, In.	Cutter No.	Corrected Depth, In.	Cutter No.	Corrected Depth, In.	Cutter No.	Corrected Depth, In.
36	Pinion	8	2.1737	8	2.1623	7	2.1757	7	2.1662	7	2.1579	6	2.1784	6	2.1710	6	2.1641	6	2.1582
	Gear	3	2.2003	3	2.2117	3	2.1983	3	2.2078	3	2.2161	3	2.1956	3	2.2030	3	2.2099	3	2.2158
37	Pinion	8	2.1751	8	2.1636	7	2.1772	7	2.1677	7	2.1594	6	2.1801	6	2.1726	6	2.1659	6	2.1599
	Gear	3	2.1989	3	2.2104	3	2.1968	3	2.2063	3	2.2146	3	2.1939	3	2.2014	3	2.2081	3	2.2141
38	Pinion	8	2.1763	8	2.1649	7	2.1786	7	2.1691	7	2.1608	6	2.1818	6	2.1743	6	2.1675	6	2.1616
	Gear	3	2.1977	3	2.2091	3	2.1954	3	2.2049	3	2.2132	3	2.1922	3	2.1997	3	2.2065	3	2.2124
39	Pinion	8	2.1775	8	2.1661	7	2.1800	7	2.1705	7	2.1621	6	2.1833	6	2.1758	6	2.1690	5	2.1934
	Gear	3	2.1965	3	2.2079	3	2.1940	3	2.2035	3	2.2119	3	2.1907	3	2.1982	3	2.2050	3	2.1806
40	Pinion	8	2.1787	8	2.1673	7	2.1813	7	2.1718	7	2.1633	6	2.1848	6	2.1773	6	2.1705	5	2.1951
	Gear	3	2.1953	3	2.2067	3	2.1927	3	2.2022	3	2.2106	3	2.1892	3	2.1967	3	2.2035	3	2.1789
41	Pinion	8	2.1798	8	2.1683	7	2.1825	7	2.1730	6	2.1946	6	2.1862	6	2.1787	6	2.1719	5	2.1967
	Gear	3	2.1942	3	2.2057	3	2.1915	3	2.2010	3	2.1794	3	2.1878	3	2.1953	3	2.2021	3	2.1773
42	Pinion	8	2.1808	8	2.1693	7	2.1836	7	2.1741	6	2.1959	6	2.1875	6	2.1800	6	2.1732	5	2.1982
	Gear	3	2.1932	3	2.2047	3	2.1904	3	2.1999	3	2.1781	3	2.1865	3	2.1940	3	2.2008	3	2.1758
43	Pinion	8	2.1819	7	2.1950	7	2.1848	7	2.1753	6	2.1972	6	2.1888	6	2.1813	5	2.2066	5	2.1997
	Gear	3	2.1921	3	2.1790	3	2.1892	3	2.1987	3	2.1768	3	2.1852	3	2.1927	3	2.1674	3	2.1743
44	Pinion	8	2.1827	7	2.1960	7	2.1858	7	2.1763	6	2.1984	6	2.1900	6	2.1825	5	2.2080	5	2.2011
	Gear	3	2.1913	3	2.1780	3	2.1882	3	2.1977	3	2.1756	3	2.1840	3	2.1915	3	2.1660	3	2.1729
45	Pinion	8	2.1836	7	2.1971	7	2.1868	7	2.1774	6	2.1996	6	2.1912	6	2.1837	5	2.2093	5	2.2024
	Gear	3	2.1904	3	2.1769	3	2.1872	3	2.1966	3	2.1744	3	2.1828	3	2.1903	3	2.1647	3	2.1716
46	Pinion	8	2.1845	7	2.1980	7	2.1878	7	2.1783	6	2.2006	6	2.1922	6	2.1848	5	2.2106	5	2.2037
	Gear	3	2.1895	3	2.1760	3	2.1862	3	2.1957	3	2.1734	3	2.1818	3	2.1892	3	2.1634	3	2.1703
47	Pinion	8	2.1854	7	2.1989	7	2.1887	7	2.1792	6	2.2017	6	2.1933	6	2.1858	5	2.2118	5	2.2049
	Gear	3	2.1886	3	2.1751	3	2.1853	3	2.1948	3	2.1723	3	2.1807	3	2.1882	3	2.1622	3	2.1691
48	Pinion	8	2.1862	7	2.1999	7	2.1896	7	2.1801	6	2.2027	6	2.1943	6	2.1868	5	2.2130	5	2.2061
	Gear	3	2.1878	3	2.1741	3	2.1844	3	2.1939	3	2.1713	3	2.1797	3	2.1872	3	2.1610	3	2.1679
49	Pinion	8	2.1869	7	2.2006	7	2.1904	6	2.2132	6	2.2037	6	2.1953	6	2.1570	5	2.2141	5	2.2072
	Gear	3	2.1871	3	2.1734	3	2.1836	3	2.1608	3	2.1703	3	2.1787	2	2.2170	3	2.1599	3	2.1668
50	Pinion	8	2.1877	7	2.2015	7	2.1913	6	2.2142	6	2.2046	6	2.1962	6	2.1580	5	2.2151	5	2.2082
	Gear	3	2.1863	3	2.1725	3	2.1827	3	2.1598	3	2.1694	3	2.1778	2	2.2160	3	2.1589	3	2.1658
51	Pinion	8	2.1883	7	2.2023	7	2.1921	6	2.2150	6	2.2055	6	2.1971	6	2.1590	5	2.2162	5	2.2092
	Gear	3	2.1857	3	2.1717	3	2.1819	3	2.1590	3	2.1685	3	2.1769	2	2.2150	3	2.1578	3	2.1648
52	Pinion	8	2.1890	7	2.2030	7	2.1928	6	2.2159	6	2.2064	6	2.1980	6	2.1599	5	2.2170	5	2.2102
	Gear	3	2.1850	3	2.1710	3	2.1812	3	2.1581	3	2.1676	3	2.1760	2	2.2141	3	2.1570	3	2.1638
53	Pinion	8	2.1897	7	2.2037	7	2.1936	6	2.2167	6	2.2072	6	2.1988	6	2.1609	5	2.2170	5	2.2112
	Gear	3	2.1843	3	2.1703	3	2.1804	3	2.1573	3	2.1668	3	2.1752	2	2.2131	3	2.1570	3	2.1628
54	Pinion	8	2.1903	7	2.2044	7	2.1942	6	2.2170	6	2.2080	6	2.1996	6	2.1618	5	2.2170	5	2.2121
	Gear	3	2.1837	3	2.1696	3	2.1798	3	2.1570	3	2.1660	3	2.1744	2	2.2122	3	2.1570	3	2.1619
55	Pinion	8	2.1677	8	2.1570	7	2.1692	7	2.1586	7	2.1570	6	2.1712	6	2.1627	6	2.1570	6	2.1570
	Gear	2	2.2063	2	2.2170	2	2.2048	2	2.2154	2	2.2170	2	2.2028	2	2.2113	2	2.2170	2	2.2170
56	Pinion	8	2.1684	8	2.1570	7	2.1699	7	2.1593	7	2.1570	6	2.1720	6	2.1635	6	2.1570	6	2.1570
	Gear	2	2.2056	2	2.2170	2	2.2041	2	2.2147	2	2.2170	2	2.2020	2	2.2105	2	2.2170	2	2.2170
57	Pinion	8	2.1690	8	2.1570	7	2.1706	7	2.1600	7	2.1570	6	2.1728	6	2.1644	6	2.1570	6	2.1570
	Gear	2	2.2050	2	2.2170	2	2.2033	2	2.2140	2	2.2170	2	2.2012	2	2.2096	2	2.2170	2	2.2170
58	Pinion	8	2.1696	8	2.1570	7	2.1713	7	2.1606	7	2.1570	6	2.1736	6	2.1651	6	2.1575	6	2.1570
	Gear	2	2.2044	2	2.2170	2	2.2027	2	2.2134	2	2.2170	2	2.2004	2	2.2089	2	2.2165	2	2.2170
59	Pinion	8	2.1702	8	2.1576	7	2.1719	7	2.1613	7	2.1570	6	2.1744	6	2.1659	6	2.1583	6	2.1570
	Gear	2	2.2038	2	2.2164	2	2.2021	2	2.2127	2	2.2170	2	2.1996	2	2.2081	2	2.2157	2	2.2170
60	Pinion	8	2.1707	8	2.1581	7	2.1726	7	2.1619	7	2.1570	6	2.1751	6	2.1666	6	2.1590	6	2.1570
	Gear	2	2.2033	2	2.2159	2	2.2014	2	2.2121	2	2.2170	2	2.1989	2	2.2074	2	2.2150	2	2.2170

Table IV (Continued)—Corrected Tooth Depth with Various Combinations of Range Milling Cutters—1 D. P. Gears

No. of Teeth in Gear		Number of Teeth in Pinion								
		21	22	23	24	25	26	27	28	29
		Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.
21	Pinion	5 2.1870								
	Gear	5 2.1870								
22	Pinion	5 2.1915	5 2.1870							
	Gear	5 2.1825	5 2.1870							
23	Pinion	5 2.1957	5 2.1911	5 2.1870						
	Gear	5 2.1783	5 2.1829	5 2.1870						
24	Pinion	5 2.1995	5 2.1949	5 2.1668	5 2.1870					
	Gear	5 2.1745	5 2.1791	4 2.2072	5 2.1870					
25	Pinion	5 2.2030	5 2.1752	5 2.1706	5 2.1664	5 2.1870				
	Gear	5 2.1710	4 2.1988	4 2.2034	4 2.2076	5 2.1870				
26	Pinion	5 2.1838	5 2.1788	5 2.1742	5 2.1700	5 2.1661	4 2.1870			
	Gear	4 2.1902	4 2.1952	4 2.1998	4 2.2040	4 2.2079	4 2.1870			
27	Pinion	5 2.1871	5 2.1821	5 2.1775	5 2.1733	5 2.1694	4 2.1907	4 2.1870		
	Gear	4 2.1869	4 2.1919	4 2.1965	4 2.2007	4 2.2046	4 2.1833	4 2.1870		
28	Pinion	5 2.1902	5 2.1852	5 2.1809	5 2.1764	4 2.1981	4 2.1941	4 2.1904	4 2.1870	
	Gear	4 2.1838	4 2.1888	4 2.1931	4 2.1976	4 2.1759	4 2.1799	4 2.1836	4 2.1870	
29	Pinion	5 2.1930	5 2.1880	5 2.1834	5 2.1774	4 2.2013	4 2.1973	4 2.1936	4 2.1902	4 2.1870
	Gear	4 2.1810	4 2.1860	4 2.1806	4 2.1966	4 2.1727	4 2.1767	4 2.1804	4 2.1838	4 2.1870
30	Pinion	5 2.1957	5 2.1907	5 2.1861	4 2.2088	4 2.2043	4 2.2003	4 2.1966	4 2.1932	4 2.1899
	Gear	4 2.1783	4 2.1833	4 2.1879	4 2.1652	4 2.1697	4 2.1737	4 2.1774	4 2.1808	4 2.1841
31	Pinion	5 2.1982	5 2.1932	5 2.1589	4 2.2114	4 2.2071	4 2.2031	4 2.1994	4 2.1959	4 2.1597
	Gear	4 2.1758	4 2.1808	3 2.2151	4 2.1626	4 2.1669	4 2.1709	4 2.1746	4 2.1781	3 2.2143
32	Pinion	5 2.2006	5 2.1955	5 2.1616	4 2.2141	4 2.2097	4 2.2057	4 2.2020	4 2.1664	4 2.1627
	Gear	4 2.1734	4 2.1785	3 2.2124	4 2.1599	4 2.1643	4 2.1683	4 2.1720	3 2.2076	3 2.2113
33	Pinion	5 2.2028	5 2.1694	5 2.1641	4 2.2165	4 2.2123	4 2.2082	4 2.2045	4 2.1692	4 2.1655
	Gear	4 2.1712	3 2.2046	3 2.2099	4 2.1575	4 2.1618	4 2.1658	4 2.1695	3 2.2048	3 2.2085
34	Pinion	5 2.2048	5 2.1716	5 2.1664	4 2.2170	5 2.1573	4 2.2105	4 2.1758	4 2.1718	4 2.1682
	Gear	4 2.1692	3 2.2024	3 2.2076	4 2.1570	3 2.2167	4 2.1635	3 2.1982	3 2.2022	3 2.2058
35	Pinion	5 2.1795	5 2.1738	5 2.1686	5 2.1639	5 2.1595	4 2.1826	4 2.1783	4 2.1744	4 2.1707
	Gear	3 2.1945	3 2.2002	3 2.2054	3 2.2101	3 2.2145	3 2.1914	3 2.1957	3 2.1996	3 2.2033
36	Pinion	5 2.1816	5 2.1759	5 2.1707	5 2.1659	5 2.1616	4 2.1849	4 2.1807	4 2.1767	4 2.1730
	Gear	3 2.1924	3 2.1981	3 2.2033	3 2.2081	3 2.2124	3 2.1891	3 2.1933	3 2.1973	3 2.2010
37	Pinion	5 2.1836	5 2.1779	5 2.1727	5 2.1679	4 2.1918	4 2.1872	4 2.1829	4 2.1790	4 2.1753
	Gear	3 2.1904	3 2.1961	3 2.2013	3 2.2061	3 2.1822	3 2.1868	3 2.1911	3 2.1950	3 2.1987
38	Pinion	5 2.1854	5 2.1797	5 2.1746	5 2.1698	4 2.1939	4 2.1893	4 2.1851	4 2.1811	4 2.1775
	Gear	3 2.1886	3 2.1943	3 2.1994	3 2.2042	3 2.1801	3 2.1847	3 2.1889	3 2.1929	3 2.1965
39	Pinion	5 2.1872	5 2.1815	5 2.1763	5 2.1716	4 2.1959	4 2.1913	4 2.1871	4 2.1831	4 2.1794
	Gear	3 2.1868	3 2.1925	3 2.1977	3 2.2024	3 2.1781	3 2.1827	3 2.1869	3 2.1909	3 2.1946
40	Pinion	5 2.1889	5 2.1832	5 2.1780	4 2.2028	4 2.1978	4 2.1932	4 2.1890	4 2.1850	4 2.1813
	Gear	3 2.1851	3 2.1908	3 2.1960	3 2.1712	3 2.1762	3 2.1808	3 2.1850	3 2.1890	3 2.1927
41	Pinion	5 2.1905	5 2.1848	5 2.1796	4 2.2046	4 2.1996	4 2.1950	4 2.1908	4 2.1868	4 2.1831
	Gear	3 2.1835	3 2.1892	3 2.1944	3 2.1694	3 2.1744	3 2.1790	3 2.1832	3 2.1872	3 2.1909
42	Pinion	5 2.1920	5 2.1863	5 2.1811	4 2.2063	4 2.2014	4 2.1968	4 2.1926	4 2.1886	4 2.1849
	Gear	3 2.1820	3 2.1877	3 2.1929	3 2.1677	3 2.1726	3 2.1772	3 2.1814	3 2.1854	3 2.1891
43	Pinion	5 2.1934	5 2.1878	5 2.1826	4 2.2080	4 2.2031	4 2.1985	4 2.1942	4 2.1903	4 2.1866
	Gear	3 2.1806	3 2.1862	3 2.1914	3 2.1660	3 2.1709	3 2.1755	3 2.1798	3 2.1837	3 2.1874
44	Pinion	5 2.1948	5 2.1892	5 2.1839	4 2.2096	4 2.2046	4 2.2000	4 2.1958	4 2.1918	4 2.1881
	Gear	3 2.1792	3 2.1848	3 2.1901	3 2.1644	3 2.1694	3 2.1740	3 2.1782	3 2.1822	3 2.1859
45	Pinion	5 2.1962	5 2.1905	5 2.1853	4 2.2111	4 2.2061	4 2.2015	4 2.1973	4 2.1933	4 2.1896
	Gear	3 2.1778	3 2.1835	3 2.1887	3 2.1629	3 2.1679	3 2.1725	3 2.1767	3 2.1807	3 2.1844

Table IV (Continued)—Corrected Tooth Depth with Various Combinations of Range Milling Cutters—1 D. P. Gears

No. of Teeth in Gear		Number of Teeth in Pinion								
		21	22	23	24	25	26	27	28	29
		Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.	Cutter No. / Corrected Depth, In.
46	Pinion	5 2.1974	5 2.1917	5 2.1866	4 2.2125	4 2.2075	4 2.2029	4 2.1987	4 2.1947	4 2.1911
	Gear	3 2.1766	3 2.1823	3 2.1874	3 2.1615	3 2.1665	3 2.1711	3 2.1753	3 2.1793	3 2.1829
47	Pinion	5 2.1986	5 2.1929	5 2.1877	4 2.2139	4 2.2089	4 2.2043	4 2.2001	4 2.1961	4 2.1924
	Gear	3 2.1754	3 2.1811	3 2.1863	3 2.1601	3 2.1651	3 2.1697	3 2.1739	3 2.1779	3 2.1816
48	Pinion	5 2.1998	5 2.1941	5 2.1889	4 2.2152	4 2.2103	4 2.2056	4 2.2015	4 2.1572	4 2.1938
	Gear	3 2.1742	3 2.1799	3 2.1851	3 2.1588	3 2.1637	3 2.1684	3 2.1725	2 2.2168	3 2.1802
49	Pinion	5 2.2009	5 2.1952	5 2.1901	4 2.2165	4 2.2115	4 2.2069	4 2.2027	4 2.1587	4 2.1950
	Gear	3 2.1731	3 2.1788	3 2.1839	3 2.1575	3 2.1625	3 2.1671	3 2.1713	2 2.2153	3 2.1790
50	Pinion	5 2.2020	5 2.1615	5 2.1911	4 2.2170	4 2.2128	4 2.2082	4 2.2039	4 2.1601	4 2.1963
	Gear	3 2.1720	2 2.2125	3 2.1829	3 2.1570	3 2.1612	3 2.1658	3 2.1701	2 2.2139	3 2.1777
51	Pinion	5 2.2030	5 2.1627	5 2.1921	4 2.2170	4 2.2139	4 2.2093	4 2.2051	4 2.1615	4 2.1572
	Gear	3 2.1710	2 2.2113	3 2.1819	3 2.1570	3 2.1601	3 2.1647	3 2.1689	2 2.2125	2 2.2168
52	Pinion	5 2.2040	5 2.1638	5 2.1578	4 2.2170	4 2.2150	4 2.2105	4 2.1676	4 2.1628	4 2.1585
	Gear	3 2.1700	2 2.2102	2 2.2162	3 2.1570	3 2.1590	3 2.1635	2 2.2064	2 2.2112	2 2.2155
53	Pinion	5 2.2049	5 2.1650	5 2.1590	4 2.2170	4 2.2161	4 2.2115	4 2.1688	4 2.1641	4 2.1598
	Gear	3 2.1691	2 2.2090	2 2.2150	3 2.1570	3 2.1579	3 2.1625	2 2.2052	2 2.2099	2 2.2142
54	Pinion	5 2.2059	5 2.1660	5 2.1600	4 2.2170	4 2.2170	4 2.2126	4 2.1700	4 2.1653	4 2.1610
	Gear	3 2.1681	2 2.2080	2 2.2140	3 2.1570	3 2.1570	3 2.1614	2 2.2040	2 2.2087	2 2.2130
55	Pinion	5 2.1736	5 2.1670	5 2.1610	5 2.1570	5 2.1570	4 2.1763	4 2.1712	4 2.1666	4 2.1622
	Gear	2 2.2004	2 2.2070	2 2.2130	2 2.2170	2 2.2170	2 2.1977	2 2.2028	2 2.2074	2 2.2118
56	Pinion	5 2.1745	5 2.1680	5 2.1620	5 2.1570	5 2.1570	4 2.1774	4 2.1724	4 2.1677	4 2.1634
	Gear	2 2.1995	2 2.2060	2 2.2120	2 2.2170	2 2.2170	2 2.1966	2 2.2016	2 2.2063	2 2.2106
57	Pinion	5 2.1755	5 2.1689	5 2.1629	5 2.1574	5 2.1570	4 2.1785	4 2.1735	4 2.1688	4 2.1644
	Gear	2 2.1985	2 2.2051	2 2.2111	2 2.2166	2 2.2170	2 2.1955	2 2.2005	2 2.2052	2 2.2096
58	Pinion	5 2.1764	5 2.1699	5 2.1639	5 2.1584	5 2.1570	4 2.1796	4 2.1746	4 2.1699	4 2.1655
	Gear	2 2.1976	2 2.2041	2 2.2101	2 2.2156	2 2.2170	2 2.1944	2 2.1994	2 2.2041	2 2.2085
59	Pinion	5 2.1773	5 2.1708	5 2.1647	5 2.1592	5 2.1570	4 2.1806	4 2.1756	4 2.1709	4 2.1666
	Gear	2 2.1967	2 2.2032	2 2.2093	2 2.2148	2 2.2170	2 2.1934	2 2.1984	2 2.2031	2 2.2074
60	Pinion	5 2.1782	5 2.1716	5 2.1656	5 2.1601	5 2.1570	4 2.1816	4 2.1766	4 2.1719	4 2.1676
	Gear	2 2.1958	2 2.2024	2 2.2084	2 2.2139	2 2.2170	2 2.1924	2 2.1974	2 2.2021	2 2.2064

		30	31	32	33	34	35	36	37	38
30	Pinion	4 2.1870								
	Gear	4 2.1870								
31	Pinion	4 2.1570	4 2.1870							
	Gear	3 2.2170	4 2.1870							
32	Pinion	4 2.1593	4 2.1896	4 2.1870						
	Gear	3 2.2147	4 2.1844	4 2.1870						
33	Pinion	4 2.1621	4 2.1589	4 2.1570	4 2.1870					
	Gear	3 2.2119	3 2.2151	3 2.2170	4 2.1870					
34	Pinion	4 2.1648	4 2.1616	4 2.1585	4 2.1570	4 2.1870				
	Gear	3 2.2092	3 2.2124	3 2.2155	3 2.2170	4 2.1870				
35	Pinion	4 2.1673	4 2.1641	4 2.1610	4 2.1582	4 2.1570	3 2.1870			
	Gear	3 2.2067	3 2.2099	3 2.2130	3 2.2158	3 2.2170	3 2.1870			
36	Pinion	4 2.1696	4 2.1664	4 2.1633	4 2.1605	4 2.1579	3 2.1897	3 2.1870		
	Gear	3 2.2044	3 2.2076	3 2.2107	3 2.2135	3 2.2161	3 2.1843	3 2.1870		
37	Pinion	4 2.1718	4 2.1687	4 2.1656	4 2.1627	3 2.1953	3 2.1923	3 2.1896	3 2.1870	
	Gear	3 2.2022	3 2.2053	3 2.2084	3 2.2113	3 2.1787	3 2.1817	3 2.1844	3 2.1870	

Table IV (Continued)—Corrected Tooth Depth with Various Combinations of Range Milling Cutters —1 D. P. Gears

No. of Teeth in Gear		Number of Teeth in Pinion															
		30		31		32		33		34		35		36		37		38	
		Cutter No.	Corrected Depth, In.	Cutter No.	Corrected Depth, In.	Cutter No.	Corrected Depth, In.	Cutter No.	Corrected Depth, In.	Cutter No.	Corrected Dept, In.	Cutter No.	Corrected Depth, In.	Cutter No.	Corrected Depth, In.	Cutter No.	Corrected Depth, In.	Cutter No.	Corrected Depth, In.
38	Pinion	4	2.1740	4	2.1708	4	2.1678	3	2.2009	3	2.1978	3	2.1949	3	2.1921	3	2.1895	3	2.1870
	Gear	3	2.2000	3	2.2032	3	2.2062	3	2.1731	3	2.1762	3	2.1791	3	2.1819	3	2.1845	3	2.1870
39	Pinion	4	2.1760	4	2.1728	3	2.2066	3	2.2033	3	2.2002	3	2.1972	3	2.1945	3	2.1918	3	2.1893
	Gear	3	2.1980	3	2.2012	3	2.1674	3	2.1707	3	2.1738	3	2.1768	3	2.1795	3	2.1822	3	2.1847
40	Pinion	4	2.1779	4	2.1747	3	2.2089	3	2.2055	3	2.2024	3	2.1995	3	2.1967	3	2.1941	3	2.1916
	Gear	3	2.1961	3	2.1993	3	2.1651	3	2.1685	3	2.1716	3	2.1745	3	2.1773	3	2.1799	3	2.1824
41	Pinion	4	2.1798	3	2.2145	3	2.2110	3	2.2077	3	2.2045	3	2.2016	3	2.1988	3	2.1962	3	2.1937
	Gear	3	2.1942	3	2.1595	3	2.1630	3	2.1663	3	2.1695	3	2.1724	3	2.1752	3	2.1778	3	2.1803
42	Pinion	4	2.1815	3	2.2166	3	2.2130	3	2.2097	3	2.2066	3	2.2036	3	2.2009	3	2.1982	3	2.1957
	Gear	3	2.1925	3	2.1574	3	2.1610	3	2.1643	3	2.1674	3	2.1704	3	2.1731	3	2.1758	3	2.1783
43	Pinion	4	2.1831	3	2.2170	3	2.2150	3	2.2117	3	2.2085	3	2.2056	3	2.2028	3	2.2002	3	2.1977
	Gear	3	2.1909	3	2.1570	3	2.1590	3	2.1623	3	2.1655	3	2.1684	3	2.1712	3	2.1738	3	2.1763
44	Pinion	4	2.1847	4	2.1815	3	2.2168	3	2.2135	3	2.2104	3	2.2074	3	2.2047	3	2.2020	3	2.1995
	Gear	3	2.1893	3	2.1925	3	2.1572	3	2.1605	3	2.1636	3	2.1666	3	2.1693	3	2.1720	3	2.1745
45	Pinion	4	2.1862	4	2.1830	4	2.1800	3	2.2153	3	2.2121	3	2.2092	3	2.2064	3	2.2038	3	2.2013
	Gear	3	2.1878	3	2.1910	3	2.1940	3	2.1587	3	2.1619	3	2.1648	3	2.1676	3	2.1702	3	2.1727
46	Pinion	4	2.1876	4	2.1845	4	2.1814	3	2.2170	3	2.2138	3	2.2109	3	2.2081	3	2.2055	3	2.2030
	Gear	3	2.1864	3	2.1895	3	2.1926	3	2.1570	3	2.1602	3	2.1631	3	2.1659	3	2.1685	3	2.1710
47	Pinion	4	2.1890	4	2.1858	4	2.1828	4	2.1800	3	2.2154	3	2.2125	3	2.2097	3	2.2071	3	2.2046
	Gear	3	2.1850	3	2.1882	3	2.1912	3	2.1940	3	2.1586	3	2.1615	3	2.1643	3	2.1669	3	2.1694
48	Pinion	4	2.1904	4	2.1872	4	2.1842	4	2.1813	3	2.2170	3	2.2141	3	2.2113	3	2.2087	3	2.2062
	Gear	3	2.1836	3	2.1868	3	2.1898	3	2.1927	3	2.1570	3	2.1599	3	2.1627	3	2.1653	3	2.1678
49	Pinion	4	2.1916	4	2.1884	4	2.1854	4	2.1826	4	2.1799	3	2.2155	3	2.2128	3	2.2101	3	2.1611
	Gear	3	2.1824	3	2.1856	3	2.1886	3	2.1914	3	2.1941	3	2.1585	3	2.1612	3	2.1639	2	2.2129
50	Pinion	4	2.1928	4	2.1896	4	2.1866	4	2.1838	4	2.1811	3	2.2170	3	2.2142	3	2.2116	3	2.1629
	Gear	3	2.1812	3	2.1844	3	2.1874	3	2.1902	3	2.1929	3	2.1570	3	2.1598	3	2.1624	2	2.2111
51	Pinion	4	2.1940	4	2.1908	4	2.1878	4	2.1850	4	2.1823	3	2.2170	3	2.2156	3	2.1676	3	2.1646
	Gear	3	2.1800	3	2.1832	3	2.1862	3	2.1890	3	2.1917	3	2.1570	3	2.1584	2	2.2064	2	2.2094
52	Pinion	4	2.1951	4	2.1919	4	2.1889	4	2.1861	4	2.1834	3	2.2170	3	2.2170	3	2.1693	3	2.1662
	Gear	3	2.1789	3	2.1821	3	2.1851	3	2.1879	3	2.1906	3	2.1570	3	2.1570	2	2.2047	2	2.2078
53	Pinion	4	2.1962	4	2.1930	4	2.1900	4	2.1872	4	2.1845	3	2.2170	3	2.1740	3	2.1708	3	2.1677
	Gear	3	2.1778	3	2.1810	3	2.1840	3	2.1868	3	2.1895	3	2.1570	2	2.2000	2	2.2032	2	2.2063
54	Pinion	4	2.1570	4	2.1940	4	2.1911	4	2.1883	4	2.1856	3	2.2170	3	2.1755	3	2.1723	3	2.1692
	Gear	2	2.2170	3	2.1800	3	2.1829	3	2.1857	3	2.1884	3	2.1570	2	2.1985	2	2.2017	2	2.2048
55	Pinion	4	2.1581	4	2.1570	4	2.1570	4	2.1570	4	2.1570	3	2.1803	3	2.1770	3	2.1737	3	2.1707
	Gear	2	2.2159	2	2.2170	2	2.2170	2	2.2170	2	2.2170	2	2.1937	2	2.1970	2	2.2003	2	2.2033
56	Pinion	4	2.1593	4	2.1570	4	2.1570	4	2.1570	4	2.1570	3	2.1817	3	2.1783	3	2.1751	3	2.1720
	Gear	2	2.2147	2	2.2170	2	2.2170	2	2.2170	2	2.2170	2	2.1923	2	2.1957	2	2.1989	2	2.2020
57	Pinion	4	2.1604	4	2.1570	4	2.1570	4	2.1570	4	2.1570	3	2.1831	3	2.1797	3	2.1765	3	2.1734
	Gear	2	2.2136	2	2.2170	2	2.2170	2	2.2170	2	2.2170	2	2.1909	2	2.1943	2	2.1975	2	2.2006
58	Pinion	4	2.1615	4	2.1577	4	2.1570	4	2.1570	3	2.1880	3	2.1844	3	2.1810	3	2.1778	3	2.1747
	Gear	2	2.2125	2	2.2163	2	2.2170	2	2.2170	2	2.1860	2	2.1896	2	2.1930	2	2.1962	2	2.1993
59	Pinion	4	2.1625	4	2.1587	4	2.1570	4	2.1570	3	2.1892	3	2.1856	3	2.1822	3	2.1790	3	2.1759
	Gear	2	2.2115	2	2.2153	2	2.2170	2	2.2170	2	2.1848	2	2.1884	2	2.1918	2	2.1950	2	2.1981
60	Pinion	4	2.1635	4	2.1598	4	2.1570	4	2.1570	3	2.1904	3	2.1868	3	2.1835	3	2.1803	3	2.1772
	Gear	2	2.2105	2	2.2142	2	2.2170	2	2.2170	2	2.1836	2	2.1872	2	2.1905	2	2.1937	2	2.1968

Reduced to 6 D.P. this excess depth becomes 0.0095 in.

Ordinarily this 16-tooth pinion would be cut with a No. 7 cutter, and the excess depth for backlash would be evenly divided between the two gears. Even with the ordinary cutter, an improvement in the action would be secured by adjusting the excess depth for backlash. In this case we would have

$$n' = 14 \text{ teeth}$$
$$d = 2 \text{ "}$$

All other values are unchanged. Proceeding as before, from equation (67) we get

$$D' = \frac{3}{29 \times 26} + \frac{2}{16 \times 14} = 0.0129$$

The value of D' is a measure of the variation in velocity during one tooth movement of the gears. This last value of D' is over forty times greater than the first one. The first solution, therefore, will produce a much better running pair of gears than the second one. The latter can be greatly improved, nevertheless, by proper distribution of the excess depth of cut.

From equation (68) we get

$$b = 0.2 \times 14 \left(\frac{3}{29 \times 26} - \frac{2}{16 \times 14}\right) = -0.0139 \text{ in.}$$

From equation (70) we get for the excess depth to cut the 16-tooth pinion.

$$B' = 0.120 - \left(0.120 + 0.01386\right) \frac{26}{26 + 14} = 0.0330$$

Reduced to 6 D.P. this excess depth becomes 0.0055 in.

From equation (71) we get for the excess depth to cut the 29-tooth gear

$$B' = \left(0.120 + 0.01386\right) \frac{26}{26 + 14} = 0.0870$$

Reduced to 6 D.P. this excess depth becomes 0.0145 in.

These examples should be sufficient to indicate the use of the foregoing equations. One word of caution, however, should be given. When the tooth numbers of the cutters are both smaller than the tooth numbers of the gears, edge contact seldom occurs, whether or not a correction is made for the depth of cut. On the other hand, if the tooth number of the cutter is larger than that of the gear, edge contact will occur unless a correction is made in the depth of the cut as outlined above.

One important gear problem is how to avoid edge contact at the beginning of mesh. The tip edge of the driven tooth is a particularly dangerous edge to make contact with the flank of the driving tooth. When this danger exists in milled gears for any reason, it may always be avoided by cutting the driven gear a trifle deeper.

A table has been prepared which shows what cutter to use and the corrected depth of cut in order to employ the range milling cutters to best advantage. This is a table of 1-D.P. gears with 0.030 in. backlash. For any other diametral pitch, the tabulated depths of cut should be divided by the desired diametral pitch. The first figure shows the cutter number to use for the pinion, or smallest gear; the second figure gives the corrected depth to cut the pinion; the third figure gives the cutter number to use for the gear; while the last figure gives the corrected depth of cut for the gear. These depths of cut are based on gear blanks of correct standard outside diameters.

As an example of the use of these tables of cutters and tooth depths, we will take a pair of 6-D.P. gears with 16 and 48 teeth. The outside diameters are calculated in the usual way. We have as the formula for the outside diameter D

$$D = \frac{N + 2}{DP}$$

For 16 teeth we have $D = \frac{16 + 2}{6} = 3.0000$ in.

For 48 teeth we have $D = \frac{48 + 2}{6} = 8.3333$ in.

From the table of cutters and tooth depths for the 16-48 combination we have

Number of teeth	16	48
Cutter number	6	3
Tooth depth (for 1 D.P.)	2.2027 in.	2.1713 in.

Dividing the 1-D.P. tooth depth by 6, we get for the 6-D.P. tooth depths 0.3654 in. 0.3619 in.

The final specifications for these gears would be:

Number of teeth	16	48
Outside diameter	3.0000 in.	8.3333 in.
Cutter	6 D.P. No. 6	6 D.P. No. 3
Depth to mill	0.3654 in.	0.3619 in.
Backlash $\left(\frac{0.030}{6}\right)$	0.0050 in.	

With these, or any other milled gears, if there should be edge contact due to errors in cutting or errors in the cutters themselves, the remedy is to cut the driven gear a trifle deeper.

Saving Checking Time on Large Drawings

By John F. Hardecker

Jack and Bill, fellow chief draftsmen, were on their way to an early spring baseball game. Jack was not as enthusiastic as was his wont, and it was easy to see his mind was elsewhere than on the game ahead. In answer to Bill's adroit prompting, he finally unburdened himself.

"Its that Pyramid Company's job," Jack admitted. "We promised to get it out complete a week from today, but it looks as though we can barely get the drafting work finished by then, let alone checking the job. We've agreed to get out all the plans in accordance with their custom of having them all on large 30 x 60 in. sheets, and I've put as many men on the job now as I possibly can under the circumstances. But I'll never get the drafting work done in time to have check prints made, checked, and the drawings corrected by the end of the week."

"I've an emergency checking stunt I've used in such cases," replied Bill. "It always saves considerable time on that kind of a job.

"Just as soon as the drafting work has progressed far enough on the left hand side of the sheet, I put a checker with a piece of tracing paper on that end of the board. Placing the tracing paper over the part of the finished job which he can check without interfering with the draftsman, he goes over it and marks the tracing paper just as he would a check print. He'll very often catch an error that might be repeating itself in the details, and he really saves a lot that way. But the best part is that it does save a day or more on the average job.

"Thanks," said Jack, contentedly settling himself into his seat, "now I'll enjoy the game, for I'm certain you've given me the answer to my problem."

Continuous Fractions as a Means for Figuring Change Gears—Discussion

By Charles Kugler

ALL the methods of figuring lead gears in the *American Machinist* have depended upon tables of decimal fractions, or else a table had to be made up, as one author states. These methods are workable, but there is one, which I have been using for the last fifteen years, that I have never seen in print, either in magazine articles or in textbooks. No tables are required, and anyone familiar with continued fractions can use this method without trouble. In some cases patience is necessary to obtain a fraction that can be factored, but a solution can always be found.

For example, I recently had to find the gear combination for a ratio of 0.479 to 1.000. An incomplete set of gears, between 25 and 100 teeth, were available.

Continuous fractions are used first:

$$0.479 = \frac{479}{1000}$$

$$\begin{array}{r} 479)1000(2 \\ \underline{958} \\ 42)479(11 \\ \underline{462} \\ 17)42(2 \\ \underline{34} \\ 8)17(2 \\ \underline{16} \\ 1)8(8 \\ \underline{8} \end{array}$$

The convergents are:

$$\frac{1}{2}; \frac{11}{23}; \frac{23}{48}; \frac{57}{119}; \text{and } \frac{479}{1000}$$

They were obtained as follows:

$\frac{1}{2}$ is the closest round fraction to 0.479.

Then $\frac{11 \times 1}{(11 \times 2) + 1} = \frac{11}{23}$; $\frac{(11 \times 2) + 1}{(23 \times 2) + 2} = \frac{23}{48}$

$$\frac{(23 \times 2) + 11}{(48 \times 2) + 23} = \frac{57}{119} = 0.478991$$

$$\frac{(57 \times 8) + 23}{(119 \times 8) + 48} = \frac{479}{1000} = 0.479000$$

Using the third and fourth convergents, proceed as if the next quotient were 40 instead of 8. Any whole number could be used as a multiplier, provided the resulting numerator and denominator are not greater than the product of the two largest available gears. In the present example, the largest gears had 100 teeth. Hence $100 \times 100 = 10{,}000$, and taking the denominators of the third and fourth convergents, solve for the greatest multiplier, as follows:

$$48 + (119 \times M) = 10{,}000$$

$$M = 83$$

Any number up to 83 can then be used as a multiplier. I chose 40, thus:

$$\frac{23 + (57 \times 40)}{48 + (119 \times 40)} = \frac{2303}{4808} = 0.478995$$

$$\frac{23 + (57 \times 41)}{48 + (119 \times 41)} = \frac{2360}{4927} = 0.478995$$

These results are close to the desired ratio—about 0.01 per cent variation—but they cannot be factored into suitable gear ratios. An unlimited number of approximate ratios may be obtained from them, however.

2303	4808
57	119 Subtract
2246	4689
57	119 Subtract
2189	4570
57	119 Subtract
2132	4451
57	119 Subtract
2075	4332

Both these last figures can be factored:

$$2075 = 25 \times 83$$

$$4332 = 57 \times 76$$

$$\frac{2075}{4332} = 0.478993$$

Error = 0.479000 — 0.478993 = 0.000007

or about 0.015 per cent.

Where Schools Can Help—Discussion

By Edward Anderson

On page 562, Vol. 64, of the *American Machinist*, is an article by Lawrence Swenson stating that the present tendency is towards highly specialized workmen. Being a school instructor, and also an all-around machinist and toolmaker, I feel in a fair position to know whether or not there is a crying need for good machinists, and whether or not schools can help in the matter of furnishing capable help to industry.

We are aware that employers want help that can do the work at hand, but wouldn't they rather take an employee already within the ranks, if he can do work in more than one capacity, and the work in the first circumstance was so caught up that his services there would not be required longer?

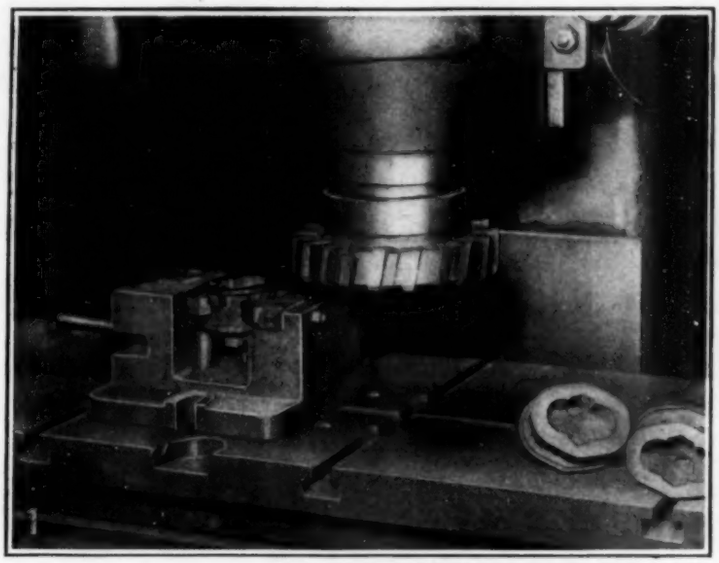
Often where specialized help is used, a workman is let out and another one hired. This involves considerable labor turnover in a short space of time, and when you witness men being let out because of no work in their own particular line and at the same time a like number being newly hired for some other specialized job, one begins to wonder what it is all about and why it needs to be.

Then here is where the trade schools can be of valuable assistance. To be sure school courses are short as compared to the time employers take to teach a boy a trade in the factory, but the writer has known of cases where apprentices in shops have been kept on one particular operation for a whole year. In other cases, even though the boys were changed every three or four months, they were not given a particle of instruction other than what they received for themselves out of the experience of a few changes of operations.

The trade schools can do much better by the boy in the way of putting actual instruction across, and that is what a trade-course is supposed to do, even though the boy may not get as much experience in manipulative processes.

I believe in specialization, but let us put a foundation under it first by giving a good sound all-around training, such as will not make machines, but will produce men and good citizens.

Automotive Production



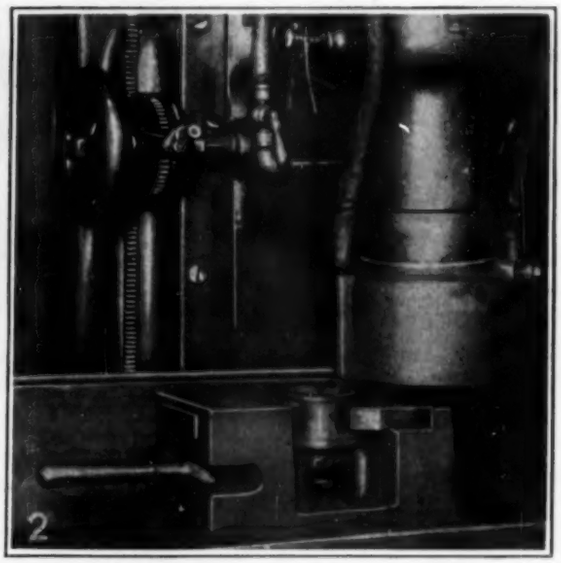


Fig. 1—Milling the joint surface. Fig. 2—Finishing by grinding

Fixtures for Machining Oil-Pump Bodies

By Fred H. Colvin
Editor, *American Machinist*

Machines and fixtures used in milling and grinding the joint surfaces — Machining the gear chambers in a lathe—Details of the fixture

THE machining of the oil-pump body for the Rickenbacker engine involves a number of operations. First the castings are heat-treated, then sand blasted, after which the joint surfaces are milled in the Cincinnati vertical milling machine shown in Fig. 1. The fixture is shown with the jaws bolted in place and with the stop pins that hold the pump body at the proper height.

The joint surfaces are finished by grinding in the abrasive machine, Fig. 2, the holding fixture being practically a duplicate of that used for milling. Then comes the boring of the two gear chambers, common in all geared pumps, this operation being performed in the turret lathe shown in Fig. 3. The fixture is of particular interest, its function being to hold the pump bodies in two positions alternately, so that both the gear chambers can be bored in correct relation. Fig. 4 gives the details of the fixture.

The fixture is designed to screw on the nose of the lathe spindle, and has the outer end supported in a steadyrest having a bronze bearing, 2¼ in. in diameter. The hole through the fixture bearing acts as a guide for the boring bars and reamers, thus insuring concentricity. The small hole is first centered, then drilled, and the gear chamber roughed out. Then the small hole is trued up with a single point boring tool and reamed to size. Finally the gear chamber is reamed, the reamer being piloted in the small hole.

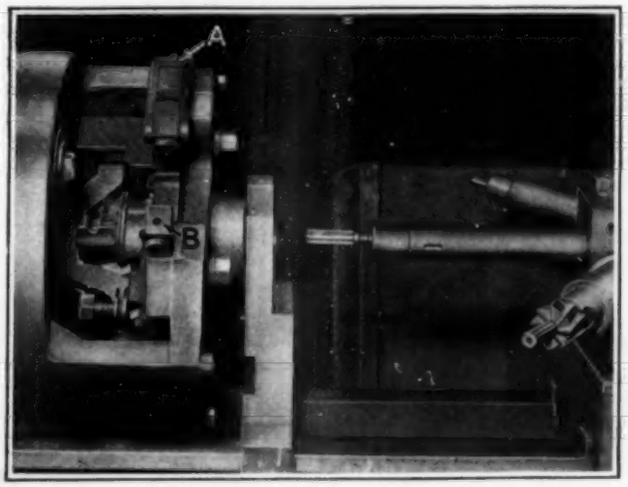


Fig. 3—Boring the gear chambers

After one chamber has been completed, the pump

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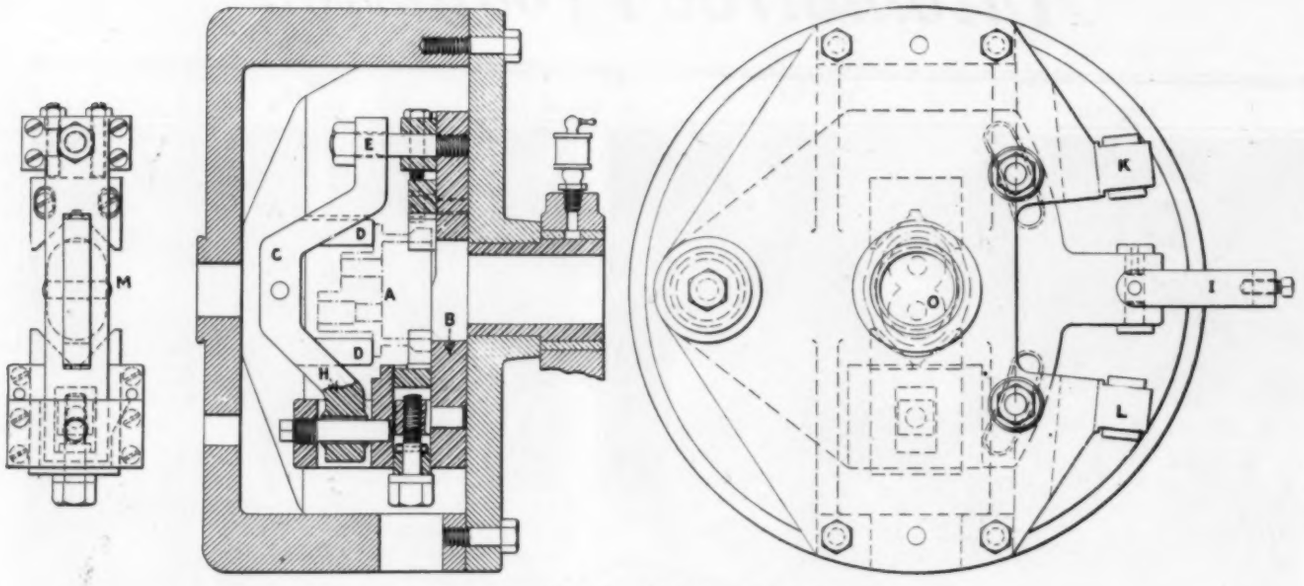


Fig. 4—Details of the boring fixture

body is shifted in the fixture by loosening the strap *A*, Fig. 3, and swinging the body forward so that the strap can go over the block *B*. Referring to Fig. 4, it will be seen that the pump body *A* is held against the front plate *B* by the equalizing clamp *C*, through the points *DD* that bear on the pump body. The clamping is done by the bolt and nut at *E*. The other end *H*, of the clamp, is made with considerable freedom so that it can accommodate itself to the work without cramping. The clamp is also shown in Fig. 4 at *I*, and the two stops or blocks at *K* and *L*. The jaws for centering the pump body and the two positions it assumes, are shown at *M* and *O*.

It is always something of a problem to bore a true hole when the periphery is not continuous, since broken or interrupted surfaces afford excellent opportunities for tools to spring. But the heavy boring tools used and the way in which the final reamer is guided at both ends, makes it possible to secure results that are very satisfactory in every way.

There are other operations, milling, drilling, tapping, burring, washing and inspecting, but they are not unusual in any way.

Causes of Babbitt-Bearing Failures

By L. D. Allen

Most failures of babbitt bearings may be traced to one or more of the following causes:

1—Excessive loads gradually crush the liner. The symptoms are heat, and complete destruction follows.

2—Bearing surfaces that have not been reamed, broached or seamed to obtain smoothness will often heat in consequence of the friction generated by the interlocking of the minute projections on the bearing surface and the journal.

3—Bearings out of alignment will heat.

4—Bearings that are keyed down too tight will also heat.

5—The lubricant may be too thick or too thin. Heat is generated by the internal friction of a viscous oil, and it is also generated by the friction of metal-to-metal contact when the oil is too thin to maintain a film that separates the bearing surfaces.

6—The use of the wrong grade of babbitt metal for the particular operating conditions often results in failure. It is generally conceded that bearing metals should be bought not on formula but on the basis of the service that can be obtained from them. The service is governed by the correct selection of the materials together with the method of alloying.

Scientific or laboratory tests are generally agreed by authorities to be unreliable. Different samples of the same formula tested under the same speed, pressure, and lubricating conditions will produce entirely different Brinell coefficient of friction, and tensile and compression figures unless the samples are all made of absolutely the same material, at the same temperature, and by the same method of alloying.

7—The metal may have been poured at the incorrect temperature, either too high or too low. Complete destruction results. Babbitts containing a high percentage of tin should be poured at a temperature of 700 deg. F., while those containing a high percentage of lead should be poured at a temperature ranging between 800 and 900 deg. Fahrenheit.

8—Grit and other foreign matter cause abrasion and wear. See that both the journal and the liner are clean when assembled and that the lubricant is always clean.

We are too apt to expect greater perfection in a machine we buy than in one we build ourselves. Yet it should be remembered that a new design of machine, built to handle some special job in a new way, is as much an experiment as is a new motor or transmission in an automobile. It may have functioned satisfactorily in the builder's shop, yet under the stress of production a few little troubles may develop. These could perhaps be remedied easily with a little friendly co-operation. But they are occasionally used as a pretext for rejection.

The Future of Export Trade in Metal-Working Machinery

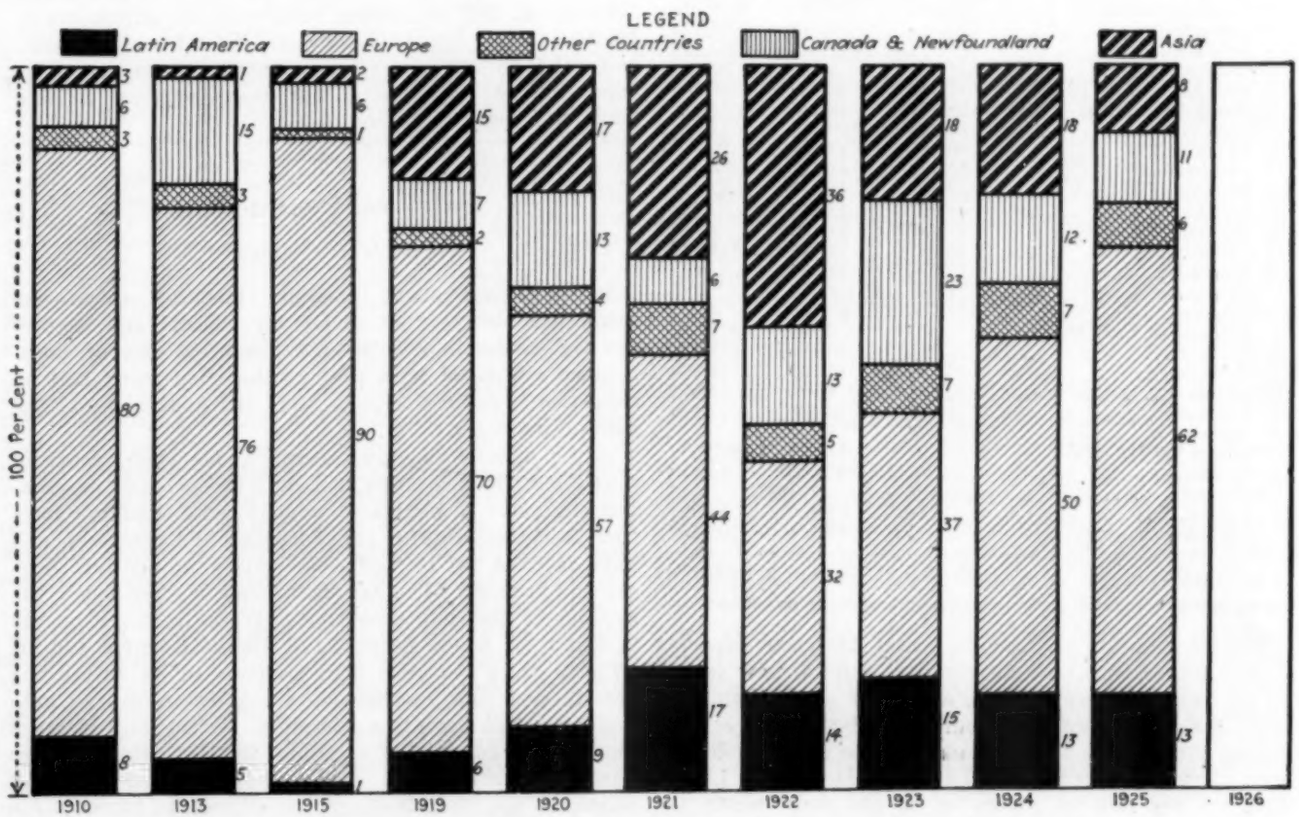
By W. H. Rastall
Chief, Industrial Machinery Division, Department of Commerce

Expansion during war years—Oversupplied markets—Recovery since 1922—Our chief competitors are also our best customers—Tendencies of the markets—Outlook for the future is good

AMERICAN metal-working machinery has long had a splendid reputation in the world's markets, and been recognized generally as the best obtainable. During the war years United States' exports of such equipment expanded very rapidly, this machinery being used extensively in European countries for the manufacture of munitions, and in all parts of the world in connection with an endless variety of industries.

Following the Armistice, practically every country in the world was over-supplied with metal-working machinery, and the demand from abroad suffered a serious collapse. Since 1922, however, there has been a constant expansion, and in 1925 for the first time exports may be regarded as exceeding the pre-war tonnage. A situation has now been reached where a reasonable demand has again developed.

Exports of metal-working machinery from the United States in 1925 were approximately $22,000,000, as compared with $14,600,000 in 1924, which is an expansion of 50 per cent. Generally speaking, it has been felt that the most serious foreign competition in this line was from British and German sources. Also it has been noted that during 1925, because of the abnormal conditions in both of those countries, manufacturers there were disposed to exert every effort in order to secure export business. Consequently, the returns shown in Table I form an interesting comparison, and show the outstanding position of American machinery of this kind in the world's markets. In this connection it should be added that during 1925 the United States shipped to Great Britain more than $4,000,000 worth of metal-working machinery, or, in other words, a volume



Percentage distribution of American exports of metal-working machinery

equivalent to more than half of that of the British exports to all destinations. Correspondingly, our manufacturers shipped to Germany nearly $3,000,000 worth of such machinery, a volume representing roughly 15 per cent of the German exports in the face of the present German price situation.

Table I—International Trade in Metal-Working Machinery

	1924	1925
American exports	$14,589,511	$22,036,796
British exports	6,019,682	7,539,108
German exports	12,721,814	18,412,394
United States to Great Britian	.....	4,053,267
United States to Germany	.....	2,986,434

Table II—Exports of American Metal-Working Machinery

Rank	Country	Value 1925	Value 1924	Value 1922
1	Great Britain	$4,053,267	$3,128,208	$2,146,554
2	Germany	2,986,434	545,315	77,120
3	France	2,429,269	2,058,521	1,034,532
4	Canada	2,328,409	1,751,692	1,640,905
5	Italy	1,724,504	304,376	82,157
6	Japan	1,204,733	1,981,033	1,480,777
7	Russia in Europe	887,923	227,972	930
8	Australia	840,796	639,749	415,830
9	Mexico	557,106	352,279	449,469
10	Chile	485,160	213,494	206,324
11	Netherlands	365,103	201,532	52,562
12	British India	361,576	336,914	2,404,884
13	Argentina	324,803	214,889	158,556
14	Spain	323,135	324,020	229,745
15	Cuba	309,160	345,761	238,199
16	Sweden	301,862	155,492	31,039
17	Brazil	299,458	187,082	240,666
18	British South Africa	268,791	222,765	62,186
19	Czechoslovakia	256,832	56,453	8,770
20	Colombia	243,818	76,544	77,676
21	Belgium	183,792	112,488	163,105
22	Venezuela	127,564	66,502	72,089
23	New Zealand	87,510	106,686	70,360
24	Dutch East Indies	85,374	48,146	14,471
25	Peru	81,718	119,749	74,664
26	Panama	70,056	47,069	10,820
27	Switzerland	66,482	43,227	8,996
28	Phillipine Islands	53,309	73,637	57,771
29	Persia	48,822	12,312	968
30	Dominican Republic	48,245	14,760	8,769
31	China	46,055	51,345	319,237
32	Norway	45,838	22,885	23,973
33	Greece	34,243	2,259	755
34	Uruguay	27,576	17,475	6,622
35	Portuguese East Africa	26,403	5,749	2,887
36	Finland	25,715	10,959	3,515
37	Honduras	25,703	42,260	24,284
38	Salvador	22,381	8,924	4,072
39	Denmark	21,634	30,402	23,593
40	Austria	20,958	5,735	.....
41	Straits Settlements	20,701	34,941	12,532
42	Guatemala	20,668	17,048	10,310
43	Hungary	20,493	224	20
44	Poland	20,144	5,486	54,962
	All other countries	253,273	285,151	201,464
	Total	$22,036,796	$14,589,511	$12,209,138

The distribution of these increased American exports is also interesting and significant. Europe now takes 62 per cent of these exports, a greater share than has been the case since 1919, although both before and during the war the shipments to Europe represented an even larger precentage. The shipments to Latin America are now in excess of 12 per cent, which is considerably above the participation of pre-war years. Expressed in dollars, the volume of these exports to Latin America during 1925 is much larger than in any preceding years with the exception of the period 1919-1921, and approximately four times as great as in the pre-war period, a fact of significance as representing the development of the needs of the countries in that area.

Similarly, the trade with Asia is noteworthy. Although it is somewhat discouraging to note the way in which the demand for such machinery has shrunken since 1919, it is still quite significant that Asia absorbs perhaps ten times as much metal-working machinery as was the case in pre-war years.

With regard to individual countries, Great Britain was the most valuable market for metal-working machinery, Germany ranked second, and France third; these three countries altogether absorbing nearly $10,000,000 worth of these products or nearly 43 per cent of the total. Remembering the competition experienced from these countries, this fact is a splendid testimonial on behalf of American metal-working machinery. The details in regard to the volumes exported to the various foreign markets are set forth in Table II, and it can be noted that in most instances the trade represented an expansion over that of previous years. In those few cases where the volume receded it was because of certain special and abnormal conditions, which we trust will not recur in the future. The marked increases in the volumes shipped to Great Britain, Germany, France, Italy, Russia, The Netherlands, Czechoslovakia, and other European countries seem to indicate that the business situation is reaching a state there which will result in more satisfactory business for some time to come.

The volume of equipment shipped to the Dutch East Indies has shown marked expansion. As previously pointed out, the increasing volume of the shipments to Mexico, Chile, Argentina, Brazil, Colombia, Venezuela, and other South American countries encourages the hope that the position of our manufacturers in this trade will continue to improve.

Sales vs. Production

BY G. B. STUART

In browsing about amongst machine shops one thing has always "got under my collar," and that is the big discrepancy between the average pay of salesmen as compared with that of the shop men; and by shop men I mean everyone from the apprentice to the general manager.

After a man has gone through the shop, drafting room, and possibly lands as a shop executive or mechanical engineer, he begins to wonder if he shouldn't have spent less time digging into formulas and processes, and have reached out to "soft-soap" his neighbor into buying the product. The salesman, who is often below the average of the shop executive in training, is out on the "profit line" where he gets full financial benefit for his efforts, while the shop man happens to be within the "production line," where costs and expenses are generally pinched down to a minimum. When sales increase and profits go up, the salesman usually gets a higher percentage or a bonus. Under the same conditions why shouldn't the Shop Manager be allowed to increase his total costs by granting an extra bonus all-around?

Hardening-Room Practice

By John J. Kauffman

While the importance of proper hardening of tools is generally recognized in the industry, there are still some shops, both large and small, in which better methods and careful thought are lacking in the hardening room.

The writer, while not an expert, is at present and has been for several years, foreman of an up-to-date toolroom equipped with modern hardening appliances. While some of the statements in this article are contrary to much of the information to be found in books and publications, especially booklets issued by steel makers, the writer asks that anyone questioning them, try the methods here given before passing judgment.

This article deals with carbon steel only. To begin with, unless you actually see a flaw or rift in the steel, assume that the steel is all right. Don't blame the steel until you have exhausted every conceivable trick to prevent breakage or failure in hardening. Remember that you have a valuable tool upon which much labor has been spent, and that the time consumed in making another will be costly. Assume that the tool foreman, the designer, and the hardener are working in harmony. The designer should always consider the difficulty of hardening a tool or die, and, wherever possible, avoid making anything with projecting edges, or a heavy piece having a thin section at some point. Making a die sectional, is oftentimes the answer to a difficult piece of work.

Breakage or loss of tools in hardening, is mostly due to one or more of the following: (1) Tools improperly designed. Dies or parts having holes too close to the edges or corners, or having thin projecting sections. If such designs cannot be avoided, the sections must be protected during heating and quenching. (2) Improper heating. The tool should be slowly and evenly heated to the proper temperature. (See accompanying table). The electric furnace with recording pyrometer is, without doubt, the best equipment obtainable. It gives absolute control of the temperature at all times, and once a chart is obtained for a certain piece of work, it may be kept as a record and the temperature duplicated at will. The amount of current fed to the furnace should be written on the chart, together with the drawing temperature and the production secured from the tool thus treated.

An oil or gas furnace may be used if equipped with a pyrometer. Keep in mind that the pyrometer rod is small and will take the furnace heat quickly, while the work may lag behind as much as several hundred degrees, due to its greater bulk and consequent slower absorption of heat. Allow one hour per inch of thickness. Be sure that the work has the same heat as the furnace, and is of uniform color all over. In a gas or oil furnace, compare the color of the work with that of the pyrometer rod and see that they are alike. In an electric furnace, the work becomes almost invisible when it has attained the furnace heat. (3) Strains in the bar stock from drawing, bending or peening while cold. This is true of drill rod, especially in the larger sizes. The remedy here is preheating. To preheat to the hardening temperature is not enough. The writer had a costly experience in this connection some time ago.

We made a number of threading dies from a large size of drill rod. Three of them were heated to 1,400 deg. F. and quenched in water. They all cracked badly. The next three were preheated to 1,400 deg. F. and allowed to cool in the air. They were then again heated to the same temperature and quenched in water. They also cracked. But we noticed that the cracks were not nearly so pronounced. The next three were preheated to 1,600 deg. F. and allowed to cool in the air. When quenched at 1,400 deg. F. they showed no cracks, and held their size perfectly. We have since hardened dozens of them with perfect results. (4) Unequal contraction during quenching. This condition is always present and is the hardest to control. It is seldom that the entire tool need be glass hard. Usually where there are projecting edges, they should be hard. Directly behind the projecting edges, hardness is not so necessary.

The temperature of the hardening bath is very important. Below 50 deg. F. is too cold, and tools quenched at that temperature are liable to crack. Above 70 or 75 deg. F., there is a decided tendency toward softness. The writer has known of several instances where tools were purposely quenched in tepid water to lessen the chances of breakage. This practice is all right where extreme hardness is not so necessary.

In hardening a solid, cylindrical piece of work, where there is a thin tubular projection on the end, the thin portion will separate neatly from the solid part. The remedy here lies in protecting the work at the proper place. Before heating, wrap a piece of sheet steel (0.020 in. thick will do) around the work for ¼ in. or more each way from the juncture, bind it tightly with a piece of soft iron wire, and quench with this covering on. The covered part will have a scleroscope hardness of from 60 to 70, while the exposed parts will show more. The tool will then be hard enough to stand severe usage.

On a heavy embossing die, where the projections consist of high ribs, or a number of fine, exposed lines that are prone to crack, the remedy is to supply a fillet of "Localhard," prepared as per directions. Begin a

Hardening and Drawing Temperatures

Article	Carbon Content Per Cent	Quench at	Bath	Draw at	Drawing Time, Hr.
Springs	0.100–0.120	1,375 to 1,425 F.	Water	635 F.	1
Tools—drill rod	0.100–0.110	1,400 to 1,425 F.	Water	375 to 450 F.	1
Threading dies	0.90 –0.110	1,400 to 1,425 F.	Water	400 F.	1
Blanking dies	0.90 –0.100	1,400 to 1,450 F.	Water or brine	400 to 450 F.	1 to 3
Embossing dies	0.90 –0.100	1,500 to 1,550 F.	Water or brine	400 to 450 F.	2 to 3
Drawing dies	0.90 –0.100	1,500 to 1,550 F.	Water or brine	325 to 375 F.	½
Cold-heading dies	0.90 –0.100	1,575 to 1,600 F.	Water or brine	400 to 450 F.	1
Cold-swaging dies	0.90 –0.100	1,675 to 1,725 F.	Water or brine	560 to 575 F.	2 to 3
Brass-turning tools	0.90 –0.100	1,425	Brine	325 F.	½

little below the highest point and round out the corner nicely. Allow it to dry, then harden the tool as usual. The tops of the ribs will be hard and the covered parts hard enough.

The commonly accepted theory, that the best heat for hardening is just above the critical point, is positively a mistake. We use all temperatures from the critical to 350 deg. F. above, depending on the size of the work, the nature of the operation intended, and the severity of usage.

Where the pressure is great and the point of contact is small, as in cold swaging, the important thing is not merely hardness, but depth of hardness. Great depth of hardness can be gotten only by heating the work to 300 deg. F. or more over the critical point.

The drawing temperature is, in this case, correspondingly high. We draw these dies to from 560 to 580 deg. F. We average more than 50,000 swagings per set of dies over a period of several years, and the dies do not sink as they once did when we quenched them at 1,500 deg. F. or less. The dies were used first for finishing, and, when they became worn, for the breaking down operation.

Whether or not the steel becomes crystallized, does not matter. What does count, is the number of finished pieces produced. Soft spots found in the steel after hardening, are almost invariably due to the formation of scale during heating. This is especially true where the heats are high, hence the importance of having a furnace that does not admit an excessive amount of oxygen. The old, coal-fired furnaces were notorious offenders in this respect. Soft spots are very objectionable on drawing dies, since the dies quickly become scored and produce bad work. Soft spots can be prevented by protecting the working surfaces.

Secure a pan of sheet steel or cast iron, ½ in. larger all around than the work. Place therein about an inch of Ivory Bone Black, and place the work in this material, face down. See that the sides are well covered for a short distance from the bottom. When heated, remove the die from the pan and quench. The face of the die will be clean and hard. The bone black may be used again, though it becomes nearly white on the first heating.

The writer is indebted to friends and acquaintances for some of these suggestions which have put us on the right track, notably Mr. Korp of the Leeds & Northrup Co., who is an expert in this line.

Reminiscences of an Old Timer

By A. J. Strong

LOOKING over the *American Machinist* for Feb. 11, on page 31 of the advertising section, I found a group photograph of some employees of Pratt & Whitney taken about 40 years ago, and have studied it with much interest to see how many of them I can call by name.

In the top row left to right I find Harry Prutting, Phil Ryan, Hugh Donohugh, and Chief Keleher. In the second row are: Herb Warren, foreman of the gear department; Fallow, "The Prisoner of Zenda," who spent his life in a vault verifying gages and measuring machines; and Al Prutting. The third row shows Jim Gray, boss polisher, inventor of the Gray pay telephone system and the baseball catchers' pad; Jim Thompson, Jim Cutler, "Monkey" Parker, John Belcher, and Eph Whitney.

In the forth row are: Macomber, who came from Taunton, Mass., as a polo player; Henry Hill; Zwicker, who would "Fix'em with a file" if they were not square; Elam Reeves; Frank Smith, foreman of the model room; Frank Carter, contractor; and Jim Duane. In the fifth row are: Pat Handy, superintendent; Jim Fox, sweeper; George Bates; Geo. Heyer, foreman of the gage department; George Hoxie; and Ike Newton. Other faces are familiar, but memory fails me and I do not recall the names.

Those were the good old days when a dial gage was unknown outside of the watch shops. Micrometers were limited to the strictly toolmakers, and machinists used scale and calipers. All fits, either drive or running, were made with a file, grinders being exclusively reserved for gage and tool work.

Micrometers were made by the Victor Sewing Machine Co. of Middletown, the screws were threaded the entire length to the anvil end, and they were corrected by making the long line on the barrel at a proper angle to intersect the zero and inch positions. On my first "mike" this angle was quite perceptible to the eye.

At the time of the photograph I had finished my apprenticeship and gone to a neighboring town as a toolmaker in a gun shop, but I knew all of these men personally. They had much to do with the development of the system of interchangeable manufacture. At that time the Page type setting machine was built, a most wonderful machine mechanically, but I understand it is now in the Museum at Cornell.

The Page machine did perfect work for books, as eleven thicknesses of spaces were used, but the perfection of the Mergenthaler type setting machine made it too slow and cumbersome. Mark Twain invested $40,000 in the Page machine. I saw him looking at it one day, and I wondered what his thoughts were. His money never came out.

When I was an apprentice working for Joe Marvel, we built some special Lincoln type millers. When they were assembled, it was found that owing to a mistake in the drawing, the worm shafts which drove the table feed screw were too short. They were sent to the blacksmith shop to have the ends cut off and the necessary length welded on, in order to save the worms which were cut solid on the shaft.

John Burnham was boss smith, a fine man, and a capable smith, a product of the Springfield Armory. When the shafts in question came back they had a piece spliced in, so that they had finished ends, with a rough section between, an impossible situation. When Mr. Marvel discovered these shafts, as the saying is, "he was tickled pink" to find that Burnham had pulled such a "boner."

As I remember these men they were a very human lot, and my association with them as a boy did not do me any harm in a mechanical way. The contractors must have made money, for all owned their homes, and some owned horses that could "step out." I believe that they felt more pride behind the horse, than does the present generation behind its "straight eight."

Ideas from Practical Men

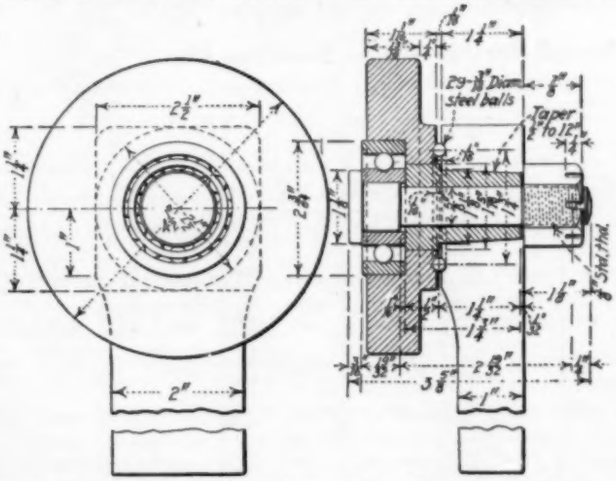
The department, "Ideas from Practical Men," is devoted to the exchange of information on methods useful to the machinery industries. Its scope includes all divisions of the machine building industry, from drafting room to shipping platform. Descriptions of methods or devices that have proved their value are carefully considered, and those published are paid for. The rates are from five dollars upward, according to their merit

A Finishing Roller

By Louis Reibel

The tool shown in the sketch is for putting a finish on journals, piston rods, crankpins, etc. While the tool, which is used in the lathe, is not new, its details differ in some respects from such tools as usually made. The difference lies in the application of ball bearings, both radial and thrust, instead of plain bearings.

In using this tool, we have found after considerable experimenting that coating the work with black oil,



Roller for finishing journals and piston rods

such as is to be found in all railroad shops, enables us to get a better finish than with oil of any other kind.

While the rolling takes considerable pressure, we have found that the ball bearings do not need adjustment oftener than once a year, and the tool has hard usage, for we roll the journals on about 30 car axles per day.

Device for Shifting Cone Belts

By Milton Wright

The illustration shows a simple and easily made device to shift the cone belt of a lathe without having to hunt up a belt stick or to risk getting a burn on the hand if the stick doesn't happen to be handy. With the exception of a few small forgings, the device is constructed of materials that may be found ready to hand in most any shop.

The upright *A* may be a piece of pipe or of cold-rolled steel of suitable size. The pipe is better, for the reason that it is not only lighter in weight in proportion to its diameter, but is much more rigid in proportion to its weight than the solid bar. The yoke through which the belt passes near the lower cone, is a forging, as are also the handle and the various brackets by which the parts are attached.

The upright rest in a swiveling bearing which is, in this case, bolted to the gear box of the lathe. The upper end turns in a loose bearing attached to a convenient part of the overhead stringer. The yoke *B* is suspended to swing from point *C* on the upright, and is provided with a handle. The handle at the lower end of the upright is jointed so that it will lie close to the latter when not in use, instead of projecting outward stiffly and being in the way of the operator every time he has occasion to shift gears.

Shifting the belt is a two-handed job. To slow the speed of the lathe, the operator first grasps with his left hand the handle of the upright, and by turning the latter causes the fork at *D* to push the belt off of the large diameter of the cone on the countershaft.

A home-made belt shifter

With his right hand he grasps the handle of the yoke and guides the belt to whatever step of the lathe cone he may desire. To speed up the lathe, the process is merely reversed.

Standard Thread Gages

By T. F. Githens

The setting of tolerances on screw threads by the National Screw Thread Commission should prove a boon to universal interchangeability, the prevention of waste and the promotion of efficiency. Previous to the establishment of these tolerances, each individual designer set his tolerances so that the point of interference, zero line, or maximum metal condition might be above, below, or on the basic line, according to his fancy.

The practical use of the report is for setting tolerances on the drawings that go to the shop, but in many shops after the class of fit has been determined, and the tolerance set down on the drawings as specified, the next step will be to design a set of thread gages. It is believed that this step is just as necessary to be standardized as the setting of tolerances. Standardization of gages would save to engineers, draftsmen, toolmakers, the time necessary to go through all the steps of designing a set of gages.

The information necessary to design a set of thread gages is given in the Report of the National Screw Thread Commission, but it is believed that if this information were given in the form of tables as shown in the one herewith, it would be of more ready use for the practical gage designer, and especially so for the designer who specifies gage sizes only occasionally.

The information for a set of Go and Not Go gages for screws for Class 2, "free fits," shown in the accompanying table, was a great help in designing gages.

Mixture for Babbitting Bearings

By E. Huff

After seeing suggestions in various copies of the *American Machinist* for methods for stopping off a bearing when babbitting, it occurred to me that all of these suggestions are lacking in one thing or another.

Asbestos and oil alone will not do the work properly. By adding one-third the volume of hemp, or even oakum, the holding properties become much more pronounced. The material retains its plasticity, and does not dry up nearly as quickly as that which is made without the use of oakum or hemp. In other words, a mixture of oakum or hemp, asbestos, and high fire test oil, will be found most suitable for the purpose.

Gages for Screws—National Fine Thread Series—Class 2—Free Fit

Size of Thread	Threads per Inch	Major Diam. of Setting Plug	Tolerance in Lead	GO GAGES					NOT GO GAGES		
				X and Y	Class X		Class Y				
				Minor Diam. of Ring	Pitch Diam. of Setting Plug	Tol. on Half Angle of Thd.	Pitch Diam. of Setting Plug	Tol. on Half Angle of Thd.	Major Diam. of Setting Plug	Pitch Diam. of Setting Plug	Minor Diam. of Setting Plug
0	80	$.0600^{+.0000}_{-.0003}$	±.0002	$.0465^{+.0000}_{-.0003}$	$.0519^{+.0000}_{-.0002}$	±0° 30′	$.0518^{+.0000}_{-.0002}$	±0° 45′	$.0566^{+.0003}_{-.0000}$	$.0502^{+.0002}_{-.0000}$	$.0465^{+.0003}_{-.0000}$
1	72	$.0730^{+.0000}_{-.0003}$	±.0002	$.0580^{+.0000}_{-.0003}$	$.0640^{+.0000}_{-.0002}$	±0° 30′	$.0639^{+.0000}_{-.0002}$	±0° 45′	$.0694^{+.0003}_{-.0000}$	$.0622^{+.0002}_{-.0000}$	$.0580^{+.0003}_{-.0000}$
2	64	$.0860^{+.0000}_{-.0004}$	±.0002	$.0691^{+.0000}_{-.0004}$	$.0759^{+.0000}_{-.0002}$	±0° 30′	$.0758^{+.0000}_{-.0003}$	±0° 45′	$.0822^{+.0004}_{-.0000}$	$.0740^{+.0002}_{-.0000}$	$.0691^{+.0004}_{-.0000}$
3	56	$.0990^{+.0000}_{-.0004}$	±.0002	$.0797^{+.0000}_{-.0004}$	$.0874^{+.0000}_{-.0002}$	±0° 30′	$.0873^{+.0000}_{-.0003}$	±0° 45′	$.0950^{+.0004}_{-.0000}$	$.0854^{+.0002}_{-.0000}$	$.0797^{+.0004}_{-.0000}$
4	48	$.1120^{+.0000}_{-.0004}$	±.0002	$.0894^{+.0000}_{-.0004}$	$.0985^{+.0000}_{-.0002}$	±0° 30′	$.0984^{+.0000}_{-.0003}$	±0° 45′	$.1076^{+.0004}_{-.0000}$	$.0963^{+.0002}_{-.0000}$	$.0894^{+.0004}_{-.0000}$
5	44	$.1250^{+.0000}_{-.0004}$	±.0002	$.1004^{+.0000}_{-.0004}$	$.1102^{+.0000}_{-.0002}$	±0° 20′	$.1101^{+.0000}_{-.0003}$	±0° 30′	$.1204^{+.0004}_{-.0000}$	$.1079^{+.0002}_{-.0000}$	$.1004^{+.0004}_{-.0000}$
6	40	$.1380^{+.0000}_{-.0004}$	±.0002	$.1109^{+.0000}_{-.0004}$	$.1218^{+.0000}_{-.0002}$	±0° 20′	$.1217^{+.0000}_{-.0003}$	±0° 30′	$.1332^{+.0004}_{-.0000}$	$.1194^{+.0002}_{-.0000}$	$.1109^{+.0004}_{-.0000}$
8	36	$.1640^{+.0000}_{-.0004}$	±.0002	$.1339^{+.0000}_{-.0004}$	$.1460^{+.0000}_{-.0002}$	±0° 20′	$.1459^{+.0000}_{-.0003}$	±0° 30′	$.1590^{+.0004}_{-.0000}$	$.1435^{+.0002}_{-.0000}$	$.1339^{+.0004}_{-.0000}$
10	32	$.1900^{+.0000}_{-.0004}$	±.0003	$.1562^{+.0000}_{-.0004}$	$.1697^{+.0000}_{-.0002}$	±0° 15′	$.1696^{+.0000}_{-.0003}$	±0° 20′	$.1846^{+.0004}_{-.0000}$	$.1670^{+.0003}_{-.0000}$	$.1562^{+.0004}_{-.0000}$
12	28	$.2160^{+.0000}_{-.0005}$	±.0003	$.1773^{+.0000}_{-.0005}$	$.1928^{+.0000}_{-.0003}$	±0° 15′	$.1926^{+.0000}_{-.0003}$	±0° 20′	$.2098^{+.0005}_{-.0000}$	$.1897^{+.0003}_{-.0000}$	$.1773^{+.0005}_{-.0000}$
1/4	28	$.2500^{+.0000}_{-.0005}$	±.0003	$.2113^{+.0000}_{-.0005}$	$.2268^{+.0000}_{-.0003}$	±0° 15′	$.2266^{+.0000}_{-.0003}$	±0° 20′	$.2438^{+.0005}_{-.0000}$	$.2237^{+.0003}_{-.0000}$	$.2113^{+.0005}_{-.0000}$
5/16	24	$.3125^{+.0000}_{-.0005}$	±.0003	$.2674^{+.0000}_{-.0005}$	$.2854^{+.0000}_{-.0003}$	±0° 15′	$.2852^{+.0000}_{-.0003}$	±0° 20′	$.3059^{+.0005}_{-.0000}$	$.2821^{+.0003}_{-.0000}$	$.2674^{+.0005}_{-.0000}$
3/8	24	$.3750^{+.0000}_{-.0005}$	±.0003	$.3299^{+.0000}_{-.0005}$	$.3479^{+.0000}_{-.0003}$	±0° 15′	$.3477^{+.0000}_{-.0003}$	±0° 20′	$.3684^{+.0005}_{-.0000}$	$.3446^{+.0003}_{-.0000}$	$.3299^{+.0005}_{-.0000}$
7/16	20	$.4375^{+.0000}_{-.0005}$	±.0003	$.3834^{+.0000}_{-.0005}$	$.4050^{+.0000}_{-.0003}$	±0° 15′	$.4048^{+.0000}_{-.0003}$	±0° 20′	$.4303^{+.0005}_{-.0000}$	$.4014^{+.0003}_{-.0000}$	$.3834^{+.0005}_{-.0000}$
1/2	20	$.5000^{+.0000}_{-.0005}$	±.0003	$.4459^{+.0000}_{-.0005}$	$.4675^{+.0000}_{-.0003}$	±0° 15′	$.4673^{+.0000}_{-.0003}$	±0° 20′	$.4928^{+.0005}_{-.0000}$	$.4639^{+.0003}_{-.0000}$	$.4459^{+.0005}_{-.0000}$
9/16	18	$.5625^{+.0000}_{-.0005}$	±.0003	$.5024^{+.0000}_{-.0005}$	$.5264^{+.0000}_{-.0003}$	±0° 15′	$.5262^{+.0000}_{-.0003}$	±0° 15′	$.5543^{+.0005}_{-.0000}$	$.5223^{+.0003}_{-.0000}$	$.5024^{+.0005}_{-.0000}$
5/8	18	$.6250^{+.0000}_{-.0005}$	±.0003	$.5649^{+.0000}_{-.0005}$	$.5889^{+.0000}_{-.0003}$	±0° 10′	$.5887^{+.0000}_{-.0003}$	±0° 15′	$.6168^{+.0005}_{-.0000}$	$.5848^{+.0003}_{-.0000}$	$.5649^{+.0005}_{-.0000}$
3/4	16	$.7500^{+.0000}_{-.0006}$	±.0003	$.6823^{+.0000}_{-.0006}$	$.7094^{+.0000}_{-.0003}$	±0° 10′	$.7092^{+.0000}_{-.0004}$	±0° 15′	$.7410^{+.0006}_{-.0000}$	$.7049^{+.0003}_{-.0000}$	$.6823^{+.0006}_{-.0000}$
7/8	14	$.8750^{+.0000}_{-.0006}$	±.0003	$.7977^{+.0000}_{-.0006}$	$.8286^{+.0000}_{-.0003}$	±0° 10′	$.8284^{+.0000}_{-.0004}$	±0° 15′	$.8652^{+.0006}_{-.0000}$	$.8237^{+.0003}_{-.0000}$	$.7977^{+.0006}_{-.0000}$
1	14	$1.0000^{+.0000}_{-.0006}$	±.0003	$.9227^{+.0000}_{-.0006}$	$.9536^{+.0000}_{-.0003}$	±0° 10′	$.9534^{+.0000}_{-.0004}$	±0° 15′	$.9902^{+.0006}_{-.0000}$	$.9487^{+.0003}_{-.0000}$	$.9227^{+.0006}_{-.0000}$

Releasing New Mainsprings

By Dexter W. Allis

In building or repairing spring-driven mechanisms, the mechanic frequently has occasion to use mainsprings as they come from the factory. If these springs are large, it is often a problem to release them from their retaining wires or rings without danger of their uncoiling suddenly and doing damage.

When a spring comes bound with wire it may be released safely if it is first wrapped with a piece of

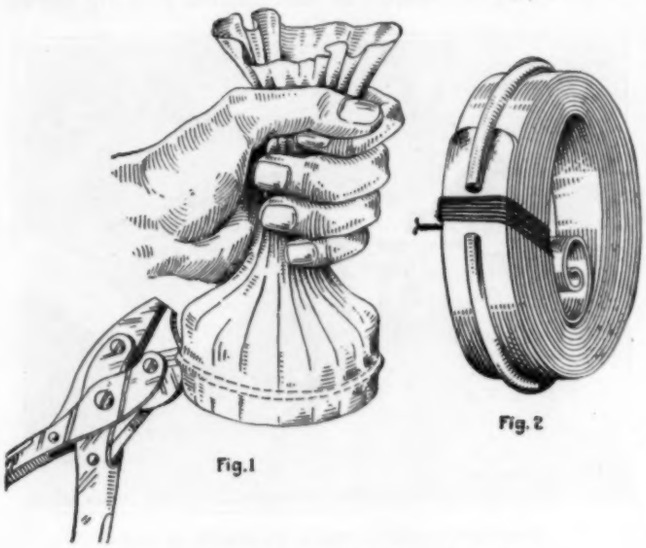


Fig. 1—Releasing a wire-bound spring
Fig. 2—Spring held by open ring

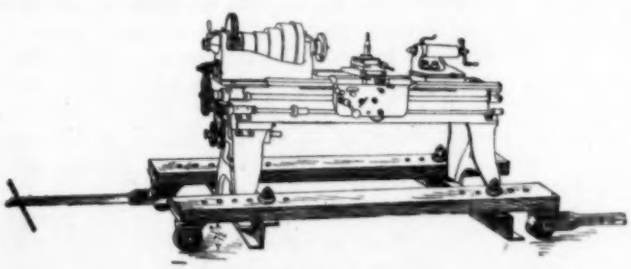
cloth, as shown in Fig. 1, and held in the hand while the retaining wire is cut, through the cloth, by the cutting pliers.

When a spring is retained by means of an open ring as in Fig. 2, it should be bound several times around with a string, or wire, passing through the center of the spring and between the ends of the ring. This binding will allow the spring to uncoil harmlessly when the ring is forced off.

Truck for Machine Moving

By Fred Fisher

A very convenient truck for moving a machine from one location to another can be made by using two, 4-in. x 6-in. timbers as stringers, and mounting them upon 6-in. swivel casters. The casters will bring the under side of the stringers (as shown in the illustration) approximately 7½ in. above the floor. Two, 3½x6x3½-in. Z-bars are used, as shown, for cross members to carry the machine. Both the stringers and the cross members have holes large enough for ¾-in. bolts, spaced at suitable intervals near the ends.



The truck in use

The end of the machine to be moved is raised slightly with a bar, and the flange of the Z-bar slipped under it. This proceeding is repeated for the other end. After the legs of the machine rest on the Z-bar flanges, the nuts on the ¾-in. bolts that are slipped through the matched holes in the stringer and Z-bars are screwed up, thereby lifting the machine so that it clears the floor and is ready to be moved in any direction by means of the swivel casters, to which guiding tongues are attached.

When the machine is approximately in its new location, the nuts are eased off, allowing the machine to be slowly lowered to the floor. In cases where a great deal of machinery moving is done, considerable time may be saved by using a cam arrangement with a lever handle in place of the bolts. With this truck, we have moved machinery weighing up to 8 tons without any difficulty.

The Use of Babbitt in Unusual Places

By H. R. Fowler

The article by E. R. Plaisted, published on page 347, Vol. 64, of the *American Machinist*, under the title "Babbitt Successfully Used for a Stressed Machine Part," reminded me of a case in my own experience where necessity was at least the stepmother of invention.

Among our machine tool equipment we have, like many another shop that has been running for a considerable number of years, a few old lathes that are little better than junk when appraised according to modern production standards, but which are still in good order physically. The floor space occupied by them is not urgently needed, and once in a while a job comes along for which they serve the purpose quite as well as could be done by more modern tools.

One day we had occasion to take the apron off of one of these old lathes, and we particularly noticed the excellent conditions of the threads in the split nut that is used in conjunction with the leadscrew to cut threads. The threads of this nut were of babbitt, poured into a cast-iron shell; and since the lathe had been in service for a good many years upon the average run of work it was safe to assume that the nut had been well tested.

A new design of machine was then being brought out upon which the principle of forced lubrication was employed, and a number of different types or methods of driving the oil pump had been suggested and experimented with, among them being a worm and wormwheel. We were then trying out a steel worm having quadruple threads of 1¼ in. pitch. The worm was 5 in. in diameter, mounted upon a spindle that ran 3,600 r.p.m, and meshed with a brass wormwheel that was but 1½ in. at its smallest diameter; therefore some very interesting experiences were promising. The sketch shows the proportions.

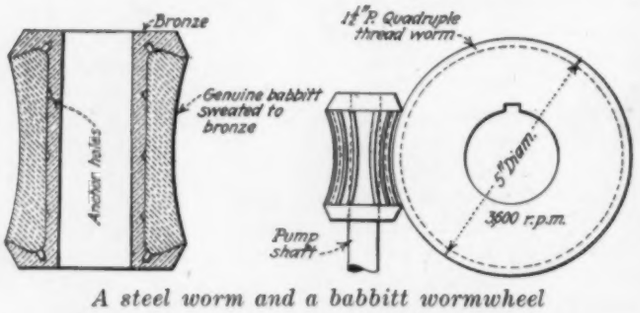
The wormwheel was keyed to a shaft that drove a standard, geared oil-pump against about 10 lb. pressure. After the machine had run for an hour or so on test, it would be noticed that particles of brass from the wormwheel were adhering to the sides of the worm threads; showing that the high-speed worm was

beginning to "do things" to the little wormwheel. We made new wheels from every kind of brass and bronze that we could get hold of, but about two days' running was the best record we could make with any of them before they started to chew up. The drive was, of course, flooded with oil while running.

In our dilemma, the smooth babbitt nut of the old lathe before mentioned came to mind, and on the principle of being willing to try anything once, we took one of the bronze wormwheels from which the teeth had been chewed off, machined it as shown in the sketch, tinned the surface, spotted a few anchor holes and poured "genuine" babbitt around it. We then machined it and hobbed the teeth in the usual way, and put it on test in the face of considerable skepticism.

The result was a surprise all round, for the new wheel ran for five days as smoothly as silk, with no sign of wear or of the metal picking up on the threads of the worm. In fact, the way that metal smoothed down reminded me of the way the fur on a cat's back lies down when it is rubbed the right way. Look at any babbitt bearing that has been in service for a long time; notice how at the oil grooves the metal has actually flowed under the continual friction, in the direction in which the shaft revolves, and contrast it with the way the granular structured brass roughens up and sticks to the shaft.

How long this drive might have run we never found out, since the machine had to be shipped and the engineers decided to abandon the drive in favor of another type in order to avoid possible complications, but as far as it went it stirred up considerable interest and



A steel worm and a babbitt wormwheel

speculation as to the possibilities of hard babbitt metal for other purposes than straight bearings. The more I see of babbitt in the bearings of heavy and high-speed machinery, the greater is my respect for it.

During the war, when antimony and copper began to climb in price, a new crop of bearing metals composed mainly of lead made their appearance on the market, and all sorts of extravagant claims were made for them. We tried out several of them, and, though the anti-friction qualities seemed to be all right, for a first-class bearing that would be subjected to the vibrations of heavy, high-speed machinery, they were too soft and were not nearly as satisfactory as the mixture—tin 85, copper 7½ and antimony 7½—that is commonly known as "genuine babbitt."

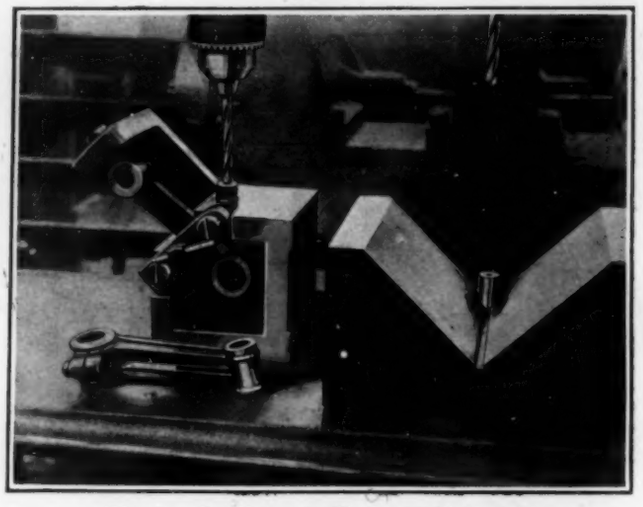
An easy way to remember whether a tolerance for a working fit should be plus, or minus, is to realize that any tolerance must be on the side that will remove metal. This shows at once that the tolerance in a hole must be plus and that on a shaft the tolerance must be minus. This method prevents making the shaft larger than the hole. For force fits the tolerances are reversed.

Turnover Jig for Small Connecting Rods

By Lester Rolfe

Keeping the tool equipment for the manufacture of a number of small connecting rods at the minimum, without sacrificing loss in production, was a problem recently encountered in a small motor shop. To provide a jig for each operation would mean considerable loading and unloading for the quantity required, and too many operations in one tool would be slow.

In place of a trunnion jig that would have to be moved from one spindle to another, the drill jig shown



Jig for drilling small connecting rods

in the illustration was designed. One oil hole in the wristpin end and two oil holes in the large end of each rod, were to be drilled from different angles. The work was located on two studs in the jig, and held in place with the swinging clamp shown at the front end. When one set of angular oil holes had been drilled, the jig was turned over 90 deg., presenting the work in correct relation for the drilling of the second set. The jig was then placed on the V-block shown at the right, presenting the rods in a perpendicular position for the drilling of the holes in the wristpin ends. A stop pin located in the V-block centralized the jig.

The tool cost for this equipment was less than would have been required for a trunnion, or indexing, jig, and the production obtained was equally as high.

A Valve-Setting Device—Discussion

By H. F. Fiedler

On page 450, Vol. 64, of the *American Machinist*, there appeared an article by Louis Reibel, under the title given above, describing a valve-setting device.

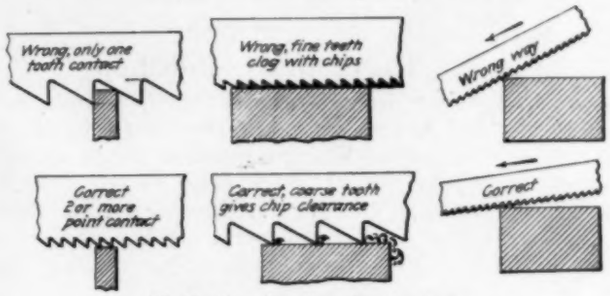
In the first place, the device can be made adjustable for any size drivers by using take-up screws, threaded on one or both ends to draw the rollers together. Furthermore, the engine may stand on any track, not necessarily over a drop pit, and the drivers can be raised by simply drawing up on the adjusting screws, thus drawing the rollers together and raising the drivers off the rail.

By means of the ratchet wrench shown by Mr. Reibel, it will take a long time to turn the wheels over. The ratchet wrench should be supplanted by power drive, either electric or air motor, through some system of gearing that will turn the wheels in from 3 to 5 minutes.

Characteristics and Use of Hacksaws

Many types and sizes of hacksaw blades are on the market with special recommendations for particular classes of work. There are a number of variable factors governing the selection and operation of the blade for any given piece of work, and in most shops it is necessary to keep a diversified stock of blades to meet the different sawing conditions.

Blades are made of carbon or alloy steels, the latter having usually a high tungsten content, which resists abrasion. A silver-steel blade is on the market for power machines for heavy solid stock. The steel for hacksaw blades requires close supervision to


Wrong, only one tooth contact
Wrong, fine teeth clog with chips
Wrong way
Correct 2 or more point contact
Correct, coarse tooth gives chip clearance
Correct

Methods of using hacksaws

assure proper uniformity of alloy and heat. Hardening and tempering also require expert care to insure proper hardness, toughness, and ductility. Blades are made with hard edge, or all hard.

The length, thickness, and width of the blade should be balanced in proportion to the size of stock to be cut. Blades too thin will buckle, while those too thick will waste time and effort. If too long the blade will bend edgewise, while blades too short are not efficient. Blades measure from center to center of hole. One maker recommends a 10-in. blade for cutting stock up to 3 in., a 12-in. blade for stock from 3 in. to 4½ in., and a 14-in. blade for stock from 4½ to 6 inches.

Thickness of blades varies from 0.025 to 0.065 in., the 0.025 and 0.032-in. sizes being most used for hand sawing, and the larger ones for power saws. One maker gives the thickness of power saws of 12-in. length as 0.032 in., and for lengths from 12 to 24 in. as 0.049 to 0.065 in. Widths of saws vary from ½ in. to 1 in., but need seldom be specified, since they are proportioned to the other dimensions.

Blades should be strained tightly in the frame. Power machines are either draw or push cut, and blades must be set accordingly. In using a handsaw put the blade tightly in the frame, take a few strokes, and then retighten.

In general, fine teeth are used for saws for cutting thin material or hard dense stock. Heavy cuts on large pieces need coarse teeth. Hack-saw teeth are designated in number per inch, or "pitch." Makers differ widely in their recommendations, and a little experiment is necessary for the shop to determine the best pitches to stock for given classes of work. In Table I are given the recommendations of one maker who approaches the average. Teeth up to 32 per in. are also made, and are recommended for fine drill rod and thin sheets. The 18-pitch blade is probably the best for all-around general handsaw use.

The standard set for hacksaws is "right, left, and raker," every third tooth, or "raker," being straight in order to break up the chips. Fine-teeth blades for cutting thin sections are sometimes made with a wavy set to prevent shelling of the teeth.

From 40 to 50 strokes per minute is the most efficient speed for hand sawing. Power saws cutting dry should operate at about 60 strokes per minute, and from 100 to 120 strokes per minute if cutting with a coolant. The saw must always be lifted on the return stroke. Slow, firm, and steady strokes will conserve the blade and give best results.

Machines are designed with strokes up to 120 per minute for the machine of 6-in. stroke, giving a blade travel of 720 in. per min. One maker offers a machine with a 12-in. stroke operating up to 80 strokes per minute, giving 965 in. per minute cutting speed. A hacksaw machine should have variable speed changes. In Table II is given a general guide for feeds on power machines.

Any ordinary shop cutting compound will serve for sawing, since the chief use is for cooling. Some-

Table I—Pitch of Hack Saws

Material To Be Cut	No. of Teeth per Inch
Annealed tool and high-speed steel	14–12
Machinery and cold rolled steel	14–10
Bronze and brass	14–12
Aluminum	10
Sheets and tubing less than ⅛ in. thick	22
Brass sheets and tubing	22–18
Drill rod and light tool steel bars	22–18

Table II—Feed of Hack Saws

Machine	With or Without Solution	Unannealed Tool Steel and Hard Metals, Strokes per Minute	Annealed Tool Steel, Strokes per Minute	Machinery Steel and Soft Metal, Strokes per Minute
Light	Without	40	50–60	50–60
Medium	Without	40	50–60	50–60
Medium	With	60	65–90	100–110
Heavy	With	60	90	110–120
Ex. heavy	With	60	90	110–120

times kerosene is recommended for cutting aluminum. In high-speed power cutting the blade and work should be deluged to prevent overheating.

Breaking of blades may be due to heavy pressure, too loose a holding strain, binding of the blade from uneven cutting, or from insecure work. Maximum pressure is used for sawing solid metals, and is reduced for thin sheets and tubes. The pressure for a 0.025-in. blade in a power machine is given by one maker as 12 lb., for a 0.032-in. blade as 20 lb., and for a 0.065-in. blade as 65 lb. If enough pressure is not used when starting a cut the blade will glaze.

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Practical Shop Problems

Questions of a Practical Nature will be answered in these columns

Installing Roller Bearings

Q. We manufacture a general line of machinery, and some special machines. We have been redesigning and incorporating changes in our products, and are considering the general adoption of ball bearings. Can you tell us what are the tendencies in the use of ball bearings, and on what principles should we proceed?

A. Of course, the specific nature of your machines will determine largely the extent to which you can adopt ball bearings. There are now, however, so many designs of ball and roller bearings on the market for different applications that you can easily find types to meet your needs, if you will consult the makers and obtain their catalogs and recommendations.

Power saving is one factor in favor of ball and roller bearings, but lubrication is an advantage of much more importance. The bearing housing has a capacity for a supply of oil or grease, and the balls or rollers will keep it distributed around the bearing surface. This feature is particularly valuable in bearings located in places difficult to reach, and which are likely to be forgotten by the operator. A ball bearing will also give a much longer wearing life than any ordinary bearing if lubricated and protected from dirt.

You should provide for oil lubrication for the ball bearings whenever possible. The best results will be obtained by the use of a refined mineral oil that will not gum. It is best to call for grease only in bearings that are difficult of access, although some makers recommend grease on low-speed bearings as it is claimed to seal the housing. As a general rule grease is not uniform, and also creates heat at high speeds.

Castings for Dies and Tools

Q. I have been reading of the claims made for a cast steel for toolroom work. Can you give me any data on this subject? I have always assumed that good forged steel was best suited for dies and tools.

A. It has been known for many years that unworked cast metals offered peculiar advantages for dies or cutting tools, but the problem has been to obtain a casting with close texture, and not brittle, that would stand the strain of the work imposed on the tool. Many years ago a press manufacturer was producing dies of chilled iron for blanking sheet metals. Chilled iron dies have also been used in munition plants for drawing cartridge shells.

The grain structure of a good casting is naturally more even than that of a piece of metal whose structure has been disturbed by rolling or forging, but the tensile strength is low, and the ordinary casting will break easily under shock when employed in a tool. The new steels being put on the market for this purpose aim to retain the qualities deriyed from the original structure of the casting, while offering a higher resistance to rupture from shock. The new properties are usually derived from alloying the steel with tungsten, chromium, or vanadium, or a proportion of all of these metals, in the electric furnace. Good results are obtained for dies, milling cutters, and even for lathe and planer tools, but the whole subject is still in an experimental stage, and is as yet limited in its application.

Die Casting in the Shop

Q. We have been informed that it is practical and economical for metal manufacturers to do their own die-casting by purchasing a machine for doing the casting. Is this correct? We have our own die rooms where we make dies for drop forgings from steel, and also dies for sheet metal work. Would our experience in making these dies be suitable for making dies for die-casting?

A. It should be entirely feasible for you to do your own die-casting if you have enough production to warrant the outlay. If you now make various sheet metal working dies and drop forging dies your toolmakers will be able to handle the requirements for casting dies.

We recommend that you read the series of articles on the principles of die-casting which appeared in Vol. 62, pages 413, 453, 487, 527, and 577, *American Machinist*. Also you should obtain a good book on the metallurgy and physical properties of the light casting alloys. Then write to the makers of die-casting machinery for catalogs and literature.

Sizes of Machine Tools

Q. I am an apprentice instructor and would appreciate an authoritative answer to the following questions. What is meant by a 54-in. boring mill? What is meant by a 36-in. lathe? How is the size of a planer given?

A. A boring mill is designated by the diameter in inches of the largest piece that can be revolved by the table between the uprights. Therefore, a 54-in. boring mill is one measuring 27 in. from the center of the table to the nearest interfering point on the uprights.

The same principle holds for a lathe. A 36-in. lathe is one capable of swinging a piece of work 36 in. in diameter, or one where the distance from the center of the spindle to the ways, or bottom of the gap, is 18 in. The British would designate such a lathe as an 18-in.-centers lathe instead of a 36-in. lathe. Formerly the designating measurements on lathes were literal, but many makers now give more capacity than the nominal.

The size of a planer is given as the largest piece of work that can be planed on it, or that will clear through the uprights and cross rail. A 36x36-in. x 8-ft. planer is one that will plane a piece 36 in. wide and 36 in. high, and has a table length, between end pockets, of 8 feet.

Technical Abstracts

Well Displayed Is Half Sold

"A machine well displayed is half sold," says H. W. Petrie, Ontario representative of sixty-seven machinery manufacturers. "Since we opened our display room, literally thousands of sales have been made that would not have been made without the display. People are telephoning in continually, asking about certain machinery, and if we did not have it in stock, where it can be seen and measurements made of it, we would not get the business.

"At the same time, many prospects from out-of-town drop in while waiting for trains and look over our stock. In this way we get in touch with prospects whom it would be difficult to reach in any other way." D. G. MacInnes in *Canadian Machinery and Manufacturing News*, April 15, p. 16.

Machine Forging

The quality of machine forgings has been improved to a marked degree in recent years. The early machines made but little effort to grip the average job sufficiently to prevent slipping, and the back stop was largely depended upon to hold the material in place. It is possible to produce machine forgings so well that the question is raised as to whether the forging machine or the drop hammer is the more efficient tool for the job.

A forging machine makes many types of forgings in confined dies where enormous pressures are thrown upon the metal with a corresponding refining tendency but as the forging machine accomplishes its purpose without noise or fuss, it does not always get credit for this increased effectiveness. Seamy bars show up more in a forging machine than in a drop hammer and probably give the impression that upsetting tends to open up the fibers of the steel. Another consideration which serves to improve the relative quality of machine forgings is that they are invariably made from rolled bars, which, of course, have the advantage of the working in rolling. The stock is forced out uniformly in all directions, with the result that there is a very uniform strength around the periphery of the forging.

Forging machine cost is lower than drop hammer cost. The production is generally twice that secured from the hammer. Present day forging machines are seldom down for repairs and there is small productive time lost on this account. Much less skill is required to operate a forging machine than to run a hammer. Charles D. Harmon, National Machinery Co., in *Forging-Stamping-Heat-Treating*, April, 1926, p. 122.

Eye Injuries

The frequency rate of eye injuries has been reduced 70 per cent and the severity rate 90 per cent during the past seven years in a large machine tool plant and the reduction was accomplished by an intensive campaign of safety in its relation to eye injuries. The first year of the campaign was inaugurated to minimize the severity of eye accidents, or to prevent them and 5,016 foreign bodies were extracted from the eyes of the employees. After four years there were only 799 pieces removed in one year at a cost of $7.50. At first there were fourteen different types of goggles in use before the company adopted a pair that suited the requirements for general work.

Some employers may think that the expense of furnishing each worker with goggles is enormous, but this is not so when the annual loss to industry from eye injury in considered. This loss exceeds $23,000,000 and 15,000 owe their blindness to industrial causes. One large company has furnished some of its workers with goggles as expensive as $28.00 a pair and considers it a good investment.

Among different causes of eye trouble, intense light is a more prolific source of serious eye conditions than are foreign bodies. For example the acetylene welder's eyes rebel against the ultra-violet rays, but protection can be easily obtained from this injurious radiant energy. Sanford De Hart, R. K. LeBlond Machine Tool Co., in *Industrial Management*, April, 1926, p. 253.

Gear Grinding

Errors of tooth indexing should be reduced to the absolute minimum so the load may be evenly distributed and the minute accelerations and decelerations which are one of the chief sources of noise may be avoided. The maximum possible tooth contact both around the profile and across the face must be obtained. The hardest possible tooth surface combined with the best finish which modern methods can produce is also necessary. The fulfilment of these conditions is only possible with the aid of the grinding wheel.

There are, generally, two processes of tooth grinding: namely, the form-wheel method and the generative process. The most efficient and economical method is that in which a form wheel takes the place of the usual cutter on a milling or gear-cutting machine, taking in sequence both a roughing and finishing cut through the tooth space. The wheel is held to its correct form by means of two diamonds set dead central with the gear arbor on which the work is mounted, the movement of the diamonds being controlled by two forms of a size which is a multiple of that of the tooth space to be ground. For each type of gear an original form is made to suit the special conditions called for, and these forms may at any time be modified when interference occurs in the gear teeth, upon inspection, or when other defects are noted in the finished gears.

It will be apparent that, when employing a wheel on the generative principle, the only possible method in which it can be applied to the teeth possesses serious limitations, since the wheel works under conditions that a practical grinding machine operator avoids if it is in any way possible to do so. It is thus only possible to remove approximately 0.002 in. to 0.003 in. from the surface of the tooth, and this amount savors of a salvage operation or, at the best, the method is only a substitute for hand stoning. H. Darbyshire, in *The Automobile Engineer (England)*, March, 1926, p. 108.

American Machinist

KENNETH H. CONDIT AND FRED H. COLVIN
Editors

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Shop Transport and Costs

PLANT layout methods have gone through several distinct changes during the past twenty-five or thirty years. We formerly built the plant according to conventional ideas and fitted the machinery equipment in as best we could. Then came the era of building the plant around the equipment—or to suit the desired layout. We are now reaching a third stage to which engineers are considering plant layout largely from the standpoint of transportation. In other words, designing plants around the best available methods of conveying material from one department to the next.

The great drawback to this method is the inevitable growth of successful concerns, this being responsible for many wastes in handling materials that now exist. It is particularly true of plants that start in a small way and expand as necessity requires, for it is seldom possible to expand logically. Even a large plant, laid out on most approved lines, is very apt to get excrescences at various points that interfere with the original plan and decrease the efficiency of the conveyor system.

The transportation of the material in a plant is frequently a factor that affects production costs more seriously than we realize.

Good Lighting Decreases Waste

PREVENTABLE waste has wrecked many individuals and businesses, and conversely, by decreasing waste many have given a favorable turn to their fortunes. What men with will power, foresight, and ingenuity have done for themselves and their industries, Secretary Hoover has been advocating for several years for the nation's industries. The results have made "waste in industry" an interesting topic. But in connection with the many methods suggested for decreasing waste and with the billions of dollars claimed to be saved annually, good lighting has rarely been mentioned.

Obviously, if light were taken away from us our production would dwindle to almost nothing. We do have light, but surely no one who has studied lighting claims that we have the necessary lighting throughout our industries for the best vision and the greatest production. We will not have that until we approach the best lighting condition outdoors. In artificial lighting we have just emerged from countless centuries of **mere** light. We do not fully appreciate the possibilities of our present-day light-sources that have been so suddenly thrust upon us.

Ligthing experts who have studied the matter claim that improved lighting in any factory would yield a return of at least several per cent of the annual production in excess of the cost of lighting. In most places the profit from good lighting would be considerably greater than this. In the industries of the country the annual profit would amount to many billions of dollars in increased production and decreased spoilage. The saving through avoidance of accidents, lessened impairment of vision and health, and increased morale is also a great figure.

In considering the reduction of waste in industry an inviting point of attack is lighting as it influences vision—the fundamental tool, and the human being—the fundamental machine, in industry. Lack of attention to this phase of human activity is costing us many times more than the combined ravages of the boll-weevil and all other destructive insects.

Progress Photographs

PHOTOGRAPHY is an invaluable method for recording and transmitting information on machine shop methods, yet surprisingly few companies are really using it to good advantage. The ones that are would hardly know what to do without it.

It is particularly useful in plants where large units are constructed, units that usually vary from each other in detail, at least. Completion of a job is so far removed from its start that the next time it is begun the men engaged on it may have forgotten just the kink that saved them a lot of time on a fussy operation. A photograph costing a few dollars would provide a permanent record of the operation and might save its cost many times over when the operation had to be repeated some time in the future.

Another use for photography in the shop is at inventory time. One engineer tried it with marked success in inventorying a shop where the work was constantly being moved about. By the time he got through counting one side he discovered that pieces at the head of the line had been moved to the other side and he had trouble in keeping them separated from the uncounted ones. Photographs of both sides taken a few minutes apart solved his problem and allowed him to count the units shown in the photographs at his leisure.

Shop photographs can be used to advantage in many ways. If you are not using them it will pay you to study the possibilities.

Shop Equipment News

Hoefer Piston-Drilling Machine

The horizontal drilling machine shown in the accompanying illustration has been placed on the market by the Hoefer Manufacturing Co., Freeport, Ill., for drilling piston pin holes. It is the first of a line of tools for this purpose and is intended chiefly for replacement and jobbing use.

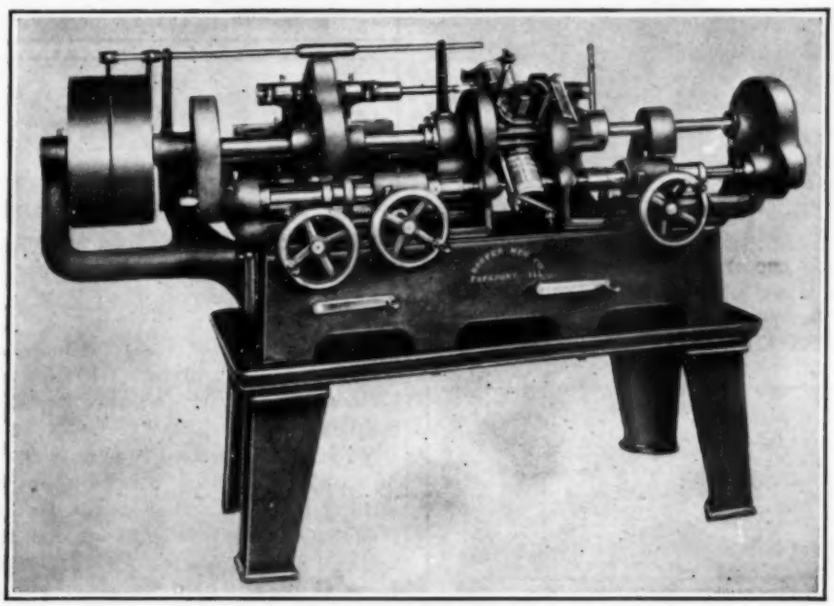
A four-position trunnion fixture carries the pistons. They are located from the same surfaces used in their manufacture so that the proper relations between the hole and the surface of the piston will be maintained.

In the first position of the fixture the pistons are located and in the second position the holes are rough drilled from each side, the drills being supported in guide bushings. In position 3, the hole is bored to size straight through from one side with two single-point tools. The two tools are spaced so that one finishes before the second begins in order to insure the correction of any error in the drilling. The boring bar is rigidly piloted. In position 4, the hole is reamed straight through from one side. The reamer has a long pilot ahead of it.

The machine is hand-operated so that the throwing in of the power feed levers is done by hand after the operator has brought the various tools up to the work.

The travel of the drills is over a short distance, each going through but one boss of the piston. The feed is in proportion to the size of the drill and is also dependent on the material of which the piston is made, cast iron or aluminum. The speed of the boring tools and of the reamer is suited to the material through which they operate, while their feed is about four times that of the drills. The boring bar of the reamer travels through the entire bushing before the tools begin cutting.

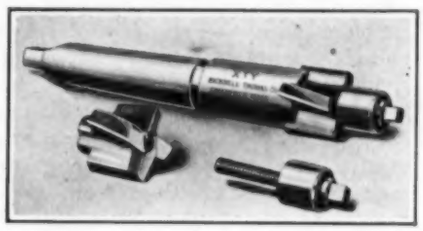
The drills and the boring and reaming tools all have automatic stops. As soon as the operation is completed the tools stop until the operator returns them to their original position. The fixture is then trunnioned to its next position and a finished piston replaced with a new one. It is claimed that the production of the machine is from sixty to seventy-five pistons per hour, depending upon the operator and the size of the piston.



Hoefer Piston-Drilling Machine

The Christy "XTY" Counterbore

The Bicknell-Thomas Co., Greenfield, Mass., has brought out a line of counterbores with interchangeable bits and pilots, that is especially designed to meet the requirements of high-production manufacturing methods. It is made in all commercial sizes ranging from ½ to 2½ in. in diameter.



The Christy "XTY" counterbore

The holders are of nickel steel, hardened, and finished by grinding. They are furnished in six sizes to cover the range of cutting bits, and with parallel or standard taper shanks. The driving shoulder is mortised to match the section of the cutting bit, making a sturdy drive in which the full diameter of the holder is effective.

The cutting bits are of section-rolled high speed steel, twisted by a special method that gives them a cutting rake comparable to that of a twist drill, and they are finished all over by grinding. A round tenon on the end of the bit fits a corresponding recess in the end of the holder, to which it is secured by a collar-head screw that passes through the bit and pilot. The illustration shows clearly the construction of the tool.

The separable pilot allows many combinations of sizes with respect to the diameter of the pilot hole. When required for work upon which especial accuracy in the matter of concentricity is necessary a one-piece bit and pilot is furnished. Bits with four lips are supplied for general purpose counterboring, and two-

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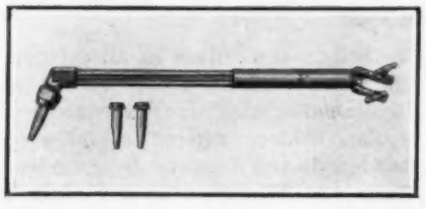
lipped bits can be furnished for spot-facing in cast iron or on other work where it is necessary to break through foundry scale or hard surfaced material of any kind.

Countersink bits are furnished of any desired angle to fit any of the holders.

Milburn Welding Torch Type J-Jr.

The Alexander Milburn Co., Baltimore, Md., is marketing the small oxy-acetylene welding torch, type J-Jr., illustrated, for work not requiring the usual standard torch. The torch uses the same tips that are supplied with the standard torches and is adaptable to all classes of welding.

Low and comparatively equal pressures of oxygen and acetylene are used with the torch, and the gases may be supplied either from generators or from tanks. It is claimed



Milburn Welding Torch, Type J-Jr.

that a uniform flame is produced as a result of the complete mixing of the gases in the passages provided for this purpose in the tip. The seats of the tips are flat and have annular grooves for gas passages corresponding with similar grooves in the head. This construction is said to permit lateral expansion of the torch head and tip without distortion. The seats can be re-faced.

The torch is made of bronze forgings and drawn stainless-steel tubing. The head is placed at an angle of 67½ deg. to the body. By means of this design it is claimed that the heat is utilized to best advantage, the operator's hand is protected, and a natural position for holding the torch is obtained. The torch is also said to be balanced so that it can be manipulated without tiring the operator.

The torch is 18 in. in length and weighs 25 oz. It is supplied with three welding tips.

Warner & Swasey "Roto" Pneumatic Grinders and Drills

Additional sizes and models of its "Roto" Pneumatic tools, previously described on page 244, Vol. 62, of the *American Machinist*, have been placed on the market by the Warner & Swasey Co., Cleveland, Ohio.

The air motor used for the tools is of the two-cylinder type. The cylinders are placed end to end, and through them runs a single shaft carrying two eccentric cylindrical rotors that are keyed in opposing positions. While one rotor is being driven under power the other is exhausted. A rotor blade rides on each rotor, so that the air is forced against the part of the rotor which bears on the side of the cylinder. After the rotor passes the outlet port where the air is exhausted it begins the cycle again.

A small clearance is provided between the rotor and the cylinder walls so as to reduce the wear. This clearance is sealed by means of an oil film in order to prevent leakage of air between the rotor and the cylinder walls. The oil reservoir, in the handle of the tools, holds an oil supply for from six to ten hours of continuous operation. The oil enters the motor along with the incoming air and its flow can be regulated by means of a needle valve.

It is claimed that the balance of the two cylinders prevents vibration of the motor and improves the quality of work that can be done. The rotor blades can be quickly replaced after removing the cover plate

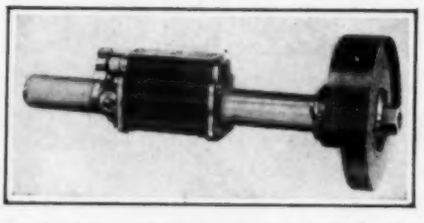
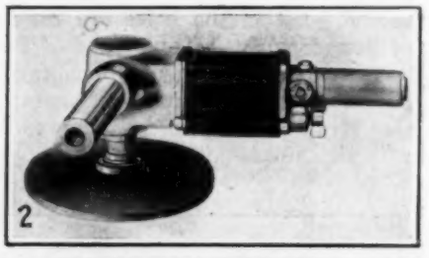


Fig. 1—Warner & Swasey "Roto" Pneumatic Grinder, Type D-1

of the rotor. A large ball bearing mounted between the two cylinders centralizes the rotor assembly in the housing.

The type D-1 grinder, illustrated in Fig. 1, is intended for general-purpose work in light grinding, buffing and polishing. When fitted with rubber-bond abrasive wheels it is suitable for grinding electric or acetylene welds. It can also be used for grinding and smoothing die molds. The tool is designed to operate at any desired speed up to 4,000 r.p.m. Its air comsumption, at 85-lb. pressure, is about 30 cu.ft. per min. A 6x1x½-in. grinding wheel is used. The weight of the type D-1 grinder is 8¾ pounds.

This type of grinder can also be provided with a shaft extension on the wheel end, which is inclosed in a tubular housing. A 4x1x½-in. grinding wheel can then be used, or it can



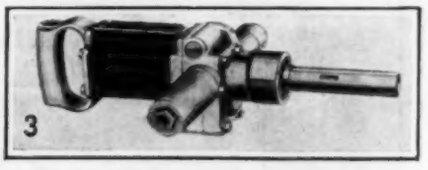


Fig. 2—Right-angle head for the grinder. Fig. 3—Warner & Swasey Pneumatic Drill, Type E-3

be equipped with a cone or cup wheel for grinding the inner surface of hollow castings which are otherwise inaccessible.

When the air pressure is only from 50 to 65 lb., the tool can be supplied with 2-to-1 reduction gears to increase its power. It can then operate a wheel 8 in. in diam. This arrangement is recommended when the tool is to be used in connection with planers, boring mills, engine lathes and for emergency grinding.

A right-angle head, illustrated in Fig. 2, can be fitted to the motor to make the tool convenient for grinding large surfaces with abrasive disks. It is designed for such work as the grinding of the surfaces of

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automobile bodies. The weight with an 8-in. disk is 13 pounds.

The type D-3 grinder is a larger size for heavy-duty work. It is designed primarily for production with large grinding wheels and under continuous service. It will carry wheels up to 2 in. wide. The load speed of this type is 3,200 r.p.m. and its free speed is 4,000 r.p.m. Its over-all length is 17½ in. and its weight without the wheel is 16 pounds.

In Fig. 3 is illustrated the E-3 pneumatic drill. It is reversible so that it can be used for driving taps, setting studs and running down nuts on assembly work. It is capable of drilling and tapping ½-in. holes through cast iron 1½ in. thick. Three models are furnished, having speeds of 500, 750 and 1,500 r.p.m. The weight of the drill is 13 pounds.

Shore Improved Direct-Reading Scleroscope

The Shore Instrument and Manufacturing Co., Jamaica, N. Y., has improved its direct-reading scleroscope, model C-2, for all-around testing purposes in manufacturing plants or laboratories. The testing

Shore Improved Scleroscope

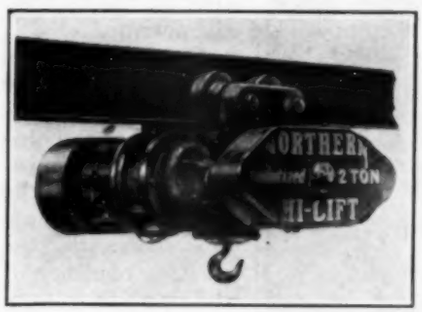
machine, shown in the accompanying illustration, supersedes the model C-1 scleroscope, previously described on page 742, Vol. 55, of the *American Machinist*. The flat clamping foot of the former machine is replaced by a graduated barrel unit so reinforced that the specimen may be securely clamped directly under it. When used with its swing arm the instrument can be located conveniently over the spot to be tested.

The features claimed for the Shore improved scleroscope are simplicity, ease of operation, sensitiveness, and as foolproof as it is possible to make a mechanism of precision. The standard rebound principle of the scleroscope is employed, and a production speed of 1,000 tests per hour is claimed for the machine.

Northern "Standart-ized Hi-Lift" Electric Hoist

The Northern Engineering Works, Detroit, Mich., is marketing the "Standart-ized Hi-Lift" electric hoist, illustrated. It is designed to run on an I-beam or for stationary mounting, and is for use in places of limited height.

Power is transmitted through



Northern "Standart-ized Hi-Lift" Electric Hoist

casehardened steel gears that are entirely inclosed and run in oil. The shafts are mounted on Timken roller bearings throughout. The hoisting drum is of large diameter and is machine finished and grooved to protect the steel hoisting wire.

Two brakes are available for holding and controlling the load. Both the upward and the downward movement of the load hook are limited by stops and it is claimed that complete unwinding of the hoisting rope cannot occur.

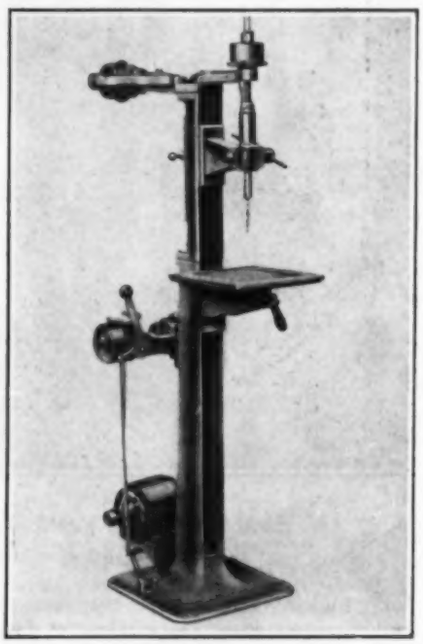
The hoist is built in sizes ranging from 1 to 4 tons. The length is 39½ in., the width, 34 in. and the clearance, 17 in. The hook lift is 20 ft. Any standard make of motor for hoisting service can be furnished. A 4-hp. motor is used for the 1, 2, and 3 ton hoist, the full-load hoisting speeds being 60, 30, and 20 ft. per min. respectively.

Robertson Sensitive Drilling Machine

A sensitive 14-in. drilling machine has been brought out by the W. Robertson Machine and Foundry Co., 56 Rano St., Buffalo, N. Y. The machine is designed for drilling holes up to ¾ in. in diam., rapidly and accurately.

Features claimed for the machine include the ball thrust bearing in the spindle and a stud-bearing mounting of the spindle pulley. The latter is designed to relieve all strain on the spindle from pull of the belt. The feed-rack is cut in the sleeve to insure positive feed. The column of the machine is rigidly built. Both the spindle head and the table are adjustable, and are clamped with a turn of a hand nut. The belt is shifted either by foot or by hand, as desired.

The machine is furnished with belt or motor drive. The net weight



Robertson Sensitive Drilling Machine

of the machine is 325 lb., and the drill occupies a floor space of 18x35 in. The height is 6½ feet.

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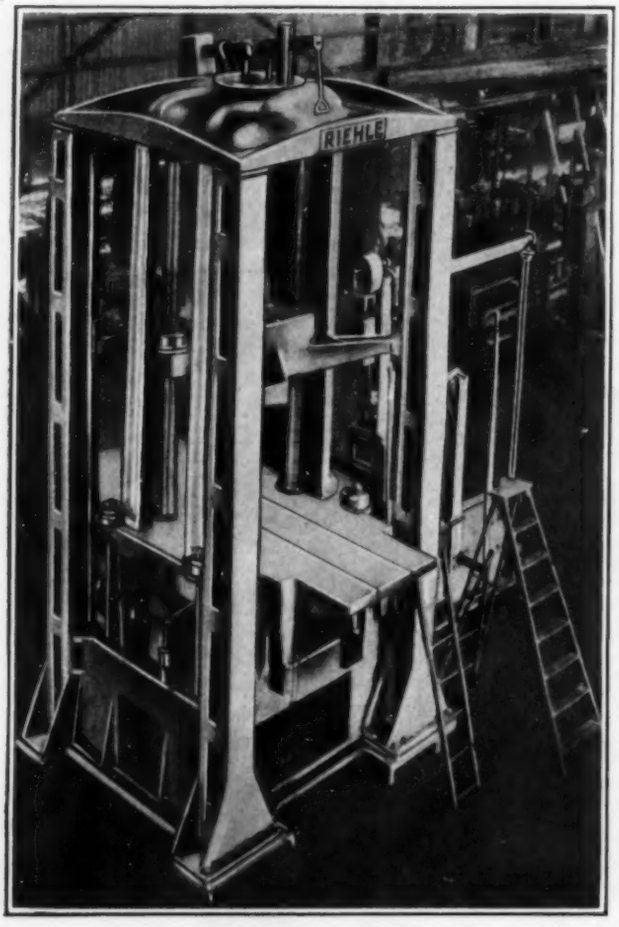
Riehlé Universal, Vertical-Screw Power Testing Machine

The Riehlé Bros. Testing Machine Co., 1424 North Ninth St., Phildelphia, Pa., has brought out a line of universal, vertical-screw power testing machines. The machines are of the "reversed screw" type, and embody the three "pulling-screws" feature.

The machine shown in the accompanying illustration has a capacity of 1,000,000 lb., and is arranged against the inside corners of the columns. The weighing-head is supported by three heavy columns, which parallel the screws and allow for the maximum of opening between the screws on three sides.

On the improved designs the rotating screw feature has been retained, so that no part of the machine projects below the base line. This feature is claimed to make a saving in foundation costs, and permits installation of large capacity machines in locations where it is not possible to cut the floor. The spacing of the three pulling screws is intended to distribute the load evenly, and to be the most convenient for observation of the test by the operator.



Riehlé Universal Vertical-Screw Power Testing Machine

The gearing is arranged so that the single screw at the front of the machine rotates in the opposite direction to the other two screws, thus neutralizing the shifting tendency of the moving head when reversing the machine.

The change gears are all carried on a main bracket which rests directly on the foundation. This bracket is designed to add stability to the structure. The driving motor runs continuously in one direction, and the starting, stopping, and reversing are accomplished by the action of a single hand lever.

The test load on the specimen is indicated on a micrometer dial up to full capacity without the use of any weights. An automatic attachment can be provided for propelling the poise, and an autographic recorder can be used to produce a stress and strain curve.

The lever weighing system is of steel castings throughout, and the gearing is bronze bushed wherever necessary. The machines are built in capacities of from 2,000 to 1,000,000 pounds.

"Hartness" High-Speed Diehead, No. 7-H

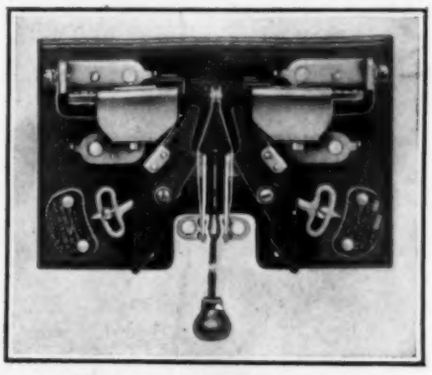
The Jones & Lamson Machine Co., Springfield, Vt., has placed on the market the No. 7-H improved "Hartness" high-speed diehead. The No. 4, type R, diehead was previously described and illustrated on page 44, Vol. 51 of the *American Machinist*.

The No. 7-H model has a capacity of from $\frac{3}{4}$ to 2 inches.

General Electric Overload Relay, Improved

The General Electric Co., Schenectady, N. Y., has re-designed the TC-121 temperature overload relay. The improved relay, illustrated, is known as form C and is designated as the TC-121-C relay.

The relay has two heating elements, which are removable. For single-phase, a.c., circuits and for d.c. circuits the heating elements are connected in each side of the line. For 2-phase, a.c., circuits an element is connected in each phase, while for 3-phase, a.c. circuits the elements are connected in two of the phases.



General Electric Overload Relay, Improved

The mechanical construction has been improved and the design is said to be such that the bending of the thermostat strips by the operator is prevented.

News of the Week

Machine Tool Builders Vote to Hold Own Exhibition in 1927

Twenty-fourth spring convention brings many to Providence—Industrial organization praised by President Lucas—Association effort is outlined by Manager DuBrul

WHAT many members hailed as the biggest forward step ever taken by the National Machine Tool Builders' Association occurred when it was voted at last week's meeting in Providence to stage a machine tool exhibition in the fall of 1927. This show will be financed and managed by the association. Arrangements are in the hands of the exposition committee of which J. Wallace Carrel is chairman.

The two days of the 24th spring convention, May 6 and 7, were filled with addresses, discussions, committee reports and routine business. Three of the sessions were held at the Providence Biltmore, the other at the attractive Squantum Club, five miles from the city, where luncheon was served through the courtesy of the Providence members.

Attitude Toward Business

At the first session the feature was the address of President H. M. Lucas. He said, in part:

"In the last few years there has been a marked change in the public's attitude toward business and business men. Some years ago, a common complaint was that business concerns were getting entirely too big. Only a short time ago, men who did wonderful work in organizing cheaper production and distribution were held up to scorn in the public press; now they are praised.

"The first attitude was common when business men were in the individualistic stage. The later attitude came about when business became cooperative in furthering the interests of business. The secretaries of Chambers of Commerce have become in effect, consulting sociologists, working to improve the civic conditions of their respective communities. The Trade Association has become a bureau of economic information for its industry, and its Secretary has become essentially a consulting economist for the industry.

"Business men spend much time on organization work, because it is good business to serve their community or industry in that fashion. They find it good business to think in terms wider than their own shop walls; to think in terms of their community, their state, their industry, their nation. Each year such work helps to make our country a better place to live in than it was the year before, and also makes it a better place to do business.

"Our own industry lives by transferring skill and intelligence from men to machines. In doing so, it contributes enormously to human progress. Without a prosperous, healthy industry making the "Master Tools of Industry" the material progress of society would be retarded. But without a good organization to speak for the industry, it will not be healthy and prosperous.

"Within the memory of most of us, the development of advertising brought with it the craftsman's pride in a painstakingly planned and built product, sold to the user on the manufacturer's reputation and name. I like to think that it is the pride of craftsmanship that is helping to pull us away from the lesser ideals of those earlier times. The manufacturer's reputation for good work must have with it a reputation for fair dealing, under the present system of business. The spirit of the old time trader, who was here today and there tomorrow, has had to give way to the necessity of more permanent methods of distribution. So the modern system cannot tolerate the methods of the past."

Fought Metric Bill

The report of the general manager, E. F. DuBrul followed. Referring to the recent hearings at Washington in the Compulsory Metric Bill, Mr. DuBrul said: "Early this year we again had to take up the cudgels against a Pro-Metric Bill in Washington. It is a thoroughly bad bill, which like all proposals for over-night reform, contemplates a wide extension of bureaucratic power to force compliance with the idealizer's theory of what is good for some other fellow.

"Various members did good work with their own Congressmen against the bill. A. C. Cook, of the Warner & Swasey Co., L. D. Burlingame, of the Brown & Sharpe Manufacturing Co., and your general manager, together with other witnesses called by the American Institute of Weights and Measures, appeared before the House Committee that was considering the bill. Early in the hearings the bill seemed to have a good chance of being favorably reported. Arguments brought forth by manufacturing interests did not seem to be making much impression on the committee. But when certain labor organizations entered their protests along with those of the manufacturers, the tide seemed to turn, and it seemed probable that the bill had met death in the committee.

"But later reports are not so reassuring. The committee now proposes to put the metric system into effect through the Department of Commerce. So more work will have to be done to save industry and the public from the evils of this legislation."

On the subject of statistics Mr. DuBrul said: "Between industries, as between individuals, exchange of information makes for more profitable operation. Our own trend of orders has been found to be a very valuable forecaster for other industries, and research men are as keen as we are, to find reliable data that shows just how all parts of the economic machine really work.

Stabilizing the Market

"Each year more and more industries are getting to gather and report and compare facts. This widespread movement is helping our industry right now. Leading executives of large buyers of machine tools are putting their brains to work on the problems of business stabilization. They are engaging qualified men to study buying, selling and production policies, with that end in view.

"As more and more of the large users of machine tools adopt this policy, we shall see more orders for machine tools placed just when we want them most, and of course, less orders placed just when we need them least. That, of course, means a more stabilized market for tools, more stabilized employment and production; more stable costs, and more stable profits. Of course improvement in these respects is bound to be slow. We shall never see the time when all machine tool buyers will have consulting economists at their elbows, nor when economists can forecast business conditions with absolute certainty.

So we can never expect to smooth out all the fluctuations in demand. They are too much a part of the very nature of machine tool demand, to hope for their elimination. We can only hope for and work toward gradual decrease in their violence, and while doing that,

we must learn to run with the tide that we cannot control."

Then came reports from the committees on advertising, relations with the Department of Commerce, membership and dealer relations. C. L. Cameron of the commerce committee reported adoption of the new machine tool classifications for customs use and stated that it was expected that the same classifications would be used by the Bureau of the Census. He urged that representatives of any member companies call at the office of the Industrial Machinery Division before sailing to get the valuable and time-saving information available there.

After luncheon at the Squantum Club an afternoon session was held which was opened by reports from the trade relations and barometer committees. Ralph E. Flanders, reporting for the latter committee, said that as the new barometer machinery was functioning satisfactorily there was no further use for his committee. It was discharged with thanks. W. A. Viall, as chairman of the trade relations committee, said that he hoped no violations of the code of ethics would be brought before his committee but that if any were, the evidence should be as substantial as if it were to be introduced in a law court. He said further that he thought the knowledge that such a committee existed would do much to check loose talk about ethical violations that could not be substantiated.

Ashamed of Profits

The first speech of the session was by W. L. Churchill, industrial engineer, whose subject was, "Insuring Profits by Intelligent Pricing." Mr. Churchill opened his remarks with the statement that only profitable concerns do much in the way of buying equipment, erecting buildings and going after increased foreign and domestic business. He said that he knew many business men who seemed to be ashamed of the fact that they made profits. The complete lack of justification for this attitude is obvious. Even a cursory examination of many industrial concerns shows non-existence of anything remotely resembling a pricing policy. Perhaps there should be a new official whose sole duty should be the setting of selling prices. Certainly it is unwise to leave this function to the president for he will usually make concessions on a deal that he would not permit his salesmen to make. He does not have to report how much of a price cut he made. Similarly, the salesman or sales manager should have no discretion in prices as he is only too apt to take the course of least resistance.

Machine tools, unlike most other items, are bought from capital, depreciation reserve or surplus instead of from income. This policy makes the merchandising of machine tools a difficult problem in view of the fact that only three out of every five users made any profits in 1925, a good year. The average return on the machinery business, from four to seven per cent, is entirely too low. The constantly increasing productive capacity of machine tools tends to shrink the market, adding still another handicap. Volume, the will-o'-the-wisp most American business men are chasing, is of no avail unless it can be had at a profit.

Mr. Churchill then stunned his listeners by the statement that the average manufacturing concern should make an annual profit equal to 100 per cent of the conversion cost. In other words, profits should equal the total cost of labor and all overhead not including raw materials or sales expense. A few minutes later some of those present recovered breath enough to ask questions and the speaker spent a busy half hour justifying his statement.

After the excitement had subsided, Roy V. Wright, editor of the *Railway Mechanical Engineer*, spoke on "Selling Machine Tools to the Railroads." Mr. Wright pointed out the drastic regulations that limit the railroad administrator on every side. What little money he has to spend must be put where it will bring the largest return. Very often this means new yards rather than machine tools. He held out little hope that 1926 would see any larger outlay for machine tools on the part of the railroads than did 1925.

Mr. Wright then told of some of the advances made by the railroads in recent years. Much progress has been made in training foremen and in giving them opportunities to visit other railroad shops. Employment has been stabilized to an extent never before equaled. Locomotives that used to run over one division only, now continue over two, three and even five divisions. As a result terminal shops have been abandoned but locomotives must be kept in better shape and consequently the backshop tools must be better ones. Some roads have embarked on long-term programs that will do much to stabilize machine tool buying.

As a result of a study made of thirteen railroads it was found that in no case can the purchasing agent override the mechanical supervisor if the latter is insistent on what he wants.

Friday morning's session was devoted to papers on "Internal Standards—Their Necessity and Advantage," by Jas. E. Gleason, Gleason Works, and "Simplification of Chaser Sizes—Its Accomplishment and Advantages to Users," by C. W. Bettcher, Eastern Machine Screw Corporation. Mr. Gleason's paper will be published in an early issue of the *American Machinist*. Mr. Bettcher told in detail how the manufacturers and users of chasers got together through the good offices of the Division of Simplified Practice of the Department of Commerce and accomplished a drastic reduction in the number of styles and sizes that will be of great benefit both to users and to manufacturers. He gave high praise to the efficient way in which the Division functioned.

At this session, J. Wallace Carrel, chairman of the exposition committee brought in a report to the effect that it had been found impossible to reach any agreement with the officers of certain associations at whose conventions machine tools are exhibited by which the Machine Tool Builders' Association could participate in the arrangements. He recommended that the Association hold its own show in 1927 and that his committee be given power to go ahead. After some discussion these recommendations were adopted through a motion that a show be held in Cleveland in the fall of 1927 and that the present committee be continued to make the necessary arrangements.

The final session was a general discussion of such subjects as the present condition of foreign trade, led by W. H. Rastall of the Department of Commerce, reconditioning and resale of one's own machines, deferred payments for machine tools, servicing machine tools and second-hand tool problems.

A.S.M.E. Regional Meeting at Providence Attracts Largest Attendance on Record

Machine shop practice, apprentice training and efficient manufacture of small parts make up program

All attendance records for regional meetings of the American Society of Mechanical Engineers went by the board in Providence, May 3 to 6. The total registration was 720, a larger number than that reached at many spring meetings. The local committee outdid itself in providing entertainment for every moment not occupied by technical sessions.

On Monday afternoon a session on industrial education was held at the rooms of the Providence Engineering Society with C. R. Burt, vice-president, the Pratt & Whitney Co., in the chair. The following papers were presented: "Has the Need for Apprenticeship Passed?" by W. A. Viall, vice-president, the Brown & Sharpe Manufacturing Co.; "Essentials of Safety Education," by George E. Sanford, safety engineer, the General Electric Co., Schenectady; "Training for Foremanship," by Frank Cushman, of the Federal Board for Vocational Education.

Mr. Viall said in part, "Many feel that the mass production which has developed the operator trained to single operations, has eliminated the necessity for the man trained to do everything. Notwithstanding this, however, there is a constant complaint being made of a shortage of skilled labor, and when business in metal-working lines begins to assume any activity, this cry is heard.

"The fact is that there is need today not only for the skilled operator who is able to handle all kinds of jobs on one type of machine, but for skilled workmen who can turn their hands to any job that they may be called upon to do. The intensive development of the 'Iron Man' which is keeping to his side one-operation operatives, has called forth a demand for leadership

and guidance. Courses of study and intensive training may give an insight into the subject, but a real leader must have a thorough, practical knowledge that can be obtained only through doing the job. I believe that school training, when successful, prepares a man to obtain the advantages of shop training in a much shorter time than is apt to be the case with an untrained mind. I firmly believe, however, that no matter how well the school training is carried out, it can in no way take the place of actual shop conditions."

A number of the members present were old Brown & Sharpe apprentices and they indorsed Mr. Viall's statement that apprenticeship of the right kind is a vital factor in the training of men for the machine industry.

Shops Must Co-operate

Mr. Burt told of his plans to introduce a similar type of apprentice training at the Pratt & Whitney Works. J. C. Spence, of the Norton Co., in a written discussion of the paper, pointed out the effect of restrictive immigration laws and the consequent need for training of skilled workers. So many such men will be needed that co-operation of many shops will be needed in producing them. They will have to build the machinery that will be needed to replace the excluded unskilled laborers.

Mr. Sanford explained how accidents at the General Electric plants have been reduced by contests involving cash prizes or trophies, education and threats as the occasion demanded. The cost of prizes or trophies was insignificant as compared with the money saved, not to mention the reduction in suffering and lost time by the employees. In Mr. Cushman's absence his paper was read by G. A. Stetson. The advantages and handicaps of the present foremen were outlined and then methods of overcoming the handicaps and making the most of the advantages were discussed. The conference method was recommended as the most successful means.

In discussing this paper Mr. Viall told how Brown & Sharpe foremen work their way up from grade to grade. Dry rot is avoided by sending them out to visit other shops and on trouble-shooting jobs.

Tuesday morning's machine shop session, presided over by J. H. Connolly, of the executive committee of the Machine Shop Practice Division, considered five papers more or less concerned with small parts manufacture: "Safety Code for Mechanical Power Transmission Apparatus," by H. G. Wiberg; "The Development of Tap-Drill Sizes," by A. C. Danekind, the General Electric Co.; "The Specification and Control of Mechanical Springs," by Jos. Kaye Wood; "Influence of Design on Production," by Professor Earle Buckingham, Massachusetts Institute of Technology; "Basis for Determining the Proportions of Standard T-Slots and Bolts," by Luther D. Burlingame, the Brown & Sharpe Manufacturing Co.

During the discussion of Professor Buckingham's paper, T. H. Nye, of the Morgan Construction Co., pointed out that simplification and standardization are just as applicable in the shop making but few of each of a considerable range of products, as in the production shop.

The paper on tap-drill sizes told of the study made at the General Electric Co., Schenectady Works, to determine proper tap-drill sizes for such materials as steel, copper and aluminum where the metal has a tendency to spin up when tapped. Existing tap-drill charts apparently ignore this effect. Standards were eventually worked out that allow for spinning up. The superiority of the ground tap was pointed out.

Mr. Burlingame's paper contained an account of the tests on T-slot bolts conducted at the Brown & Sharpe plant in connection with the work of the joint T-slot standardization committee. It is a supplement to the report of that committee.

Three subjects were discussed at the Wednesday morning session which was presided over by Erik Oberg, treasurer of the society. The first, by E. C. Mayo, president and general manager, the Gorham Manufacturing Co., was a critical analysis of the reasons for the precarious situation of some New England manufacturers. Among other pointed things, he said, "New England is the greatest dumping ground for second-hand machinery in the country. . . . Buying machine tools because they are cheap to purchase, not cheap to operate, is a dangerous philosophy. . . . With modern machine tools and its inherent mechanical ability, in spite of its geographic location, New England can compete with the world.

Bad for Future

"The present policy, pursued for a period of another ten years, will certainly cripple New England's prestige beyond a point at which it can be regained without vast expense, if at all. Every executive should make a careful analysis of his machine tool equipment and have the vision and courage to scrap the machinery that cannot be profitably operated in competition."

In discussing this paper, Ernest F. DuBrul, general manager, National Machine Tool Builders' Association, pointed out that economic law would unfailingly eliminate the concern that fell behind in its business methods.

Speaking informally, Col. T. C. Dickson, commanding officer of the Watertown Arsenal, gave an extremely interesting account of the cold-working process used in the manufacture of cannon. After the gun tube is lowered into a container, the inside dimensions of which correspond closely to the outside dimensions of the tube, hydraulic pressure is applied to expand the tube. Pressure up to 95,000 lb. per sq.in. is used, two and a half times the old proof firing powder pressure, and the resultant cold-working of the steel makes it exceedingly resistant to impact and consequently safer in case of premature explosion of the shell. Col Dickson showed the hydraulic mechanism by which the pressure is built up and gave details of the packing arrangement. He gave high credit to the civilian experts at the arsenal responsible for development of the process and pointed out the inadequacy of their pay. The speaker also reminded his hearers that the arsenal authorities are only too glad to attempt to solve problems presented to them by manufacturers. This work is done at cost, according to law.

The other paper was by F. W. Krebs, of the United Alloy Steel Corporation, and was entitled "The Cold-Drawing of Bar Steel." It described equipment used in converting hot-rolled steel into cold-drawn bars, and went into some detail as regards the factors affecting machining quality.

Social functions included a reception at the new gallery of the Rhode Island School of Design followed by a supper at the Providence Art Club. Beautiful examples of early American furniture, china and glass were on display. A luncheon with the Chamber of Commerce Committee of 100 took place Tuesday noon at which Prof. H. E. Clifford, Harvard University, spoke on the relation of the engineer to business. The speaker undertook to depict conditions in 1950 when the population of the United States will be 150,000,000. A further development of apartment house life will come and with it centralized laundries, kitchens, etc. Industry will tend to decentralize and locate near sources of raw materials. The food problem is being solved by the engineer who is making it less necessary to eat as the food supply diminishes.

A clambake followed by entertainment and dancing occupied all hands Tuesday evening and a May breakfast and dinner dance Wednesday noon and evening, respectively. The ladies were well taken care of by a committee presided over by Mrs. Henry D. Sharpe. The meeting ended in a blaze of glory Thursday with an all-day trip to the torpedo station at Newport.

Steel Treaters Meet Next Week

Combining a splendid program of topics of special interest to users of steel, and a series of visits to large industrial plants in the vicinity, the American Society for Steel Treating will hold its spring sectional meeting at Hartford, Conn., May 20 and 21. The meetings will be held at the Hotel Bond.

Among the subjects already on the program are: "Recrystallization Temperatures of Cold-Rolled Electrolytic Iron and Open-Hearth Steel Strip," by John R. Freeman, Jr., of the Bureau of Standards; "Factors Affecting the Machinability of Alloy Steels," by J. S. Vanick, of the International Nickel Co.; "Necessary Precautions in the Manufacture of Alloy Steels," by M. A. Grossman, of the United Alloy Steel Co.; "Forging by the Upset Process," by J. C. Keilman, of the New Departure Manufacturing Co.; "Heat-Treatment of Die Blocks," by Alfred J. Porter, Jr., of the Heppenstall Forge Co.

Part of the afternoon of each day will be devoted to inspection trips to factories in or near Hartford. It is planned to visit the Billings & Spencer Co., Colt's Armory, the Hartford Rubber Works, the Pratt & Whitney Co., the Royal Typewriter Co., the Underwood Typewriter Co. and the Union Drawn Steel Co.

Imports of Machine Tools to Germany Show Return to Post-War Basis

Future of market depends on purchasing power of users—Exports aided by lowering prices

The year 1925 has been a milestone in Germany's post-war development, at least as far as foreign trade is concerned. The last vestiges of the inflation period have disappeared and foreign trade has again settled down to a normal course. This is clearly indicated by the machine tool business. The total of imports, which in 1913 was 6,427 tons and which has maintained an average of 1,000 tons in the years between 1920 and 1924, has risen in 1925 to 4,508 tons. Although it remained behind that of 1913 by over 1,900 tons, its total value has, however, been by far higher. Whereas the expenditure for imported machinery in 1913 was 8.9 million marks, it amounted in 1925 to 13.9 million marks. This is, of course, due to the generally higher level of prices, but also to the fact that the class of machines imported is of a higher order.

In 1913 the average per kg. was 1.36 marks, as against 3.07 marks in 1925, or considerably more than twice as much. In 1913 imports consisted of 10,500 individual pieces of machinery; in 1925 this number was only 5,200 pieces. From this it can be seen that in the average a somewhat heavier type of machinery is now being imported.

U. S. Imports Grew

The explanation for this fact may be found partly in the changed origin of the bulk of the imported machine tools and partly in the difference of types concerned. In 1922, for instance, 472 tons out of a total of 1,353 tons came from Holland, which prior to the war hardly exported any machine tools to Germany at all, and which in the returns of 1925 figures with only 147 tons. Former German possessions supplied in 1925 74 tons, Austria and Czechoslovakia combined 377 tons, as against 160 tons in 1913. The import from Great Britain, which in 1913 was 969 tons, has during the post-war years dwindled down to insignificance, but shows in 1925 again a notable quantity of 312 tons. In fact this import was in 1925 larger than the total import in 1924 from the United States.

The most striking feature of the machine tool import in 1925 is, however, the sudden and large growth of the import from the United States. In 1925 Germany bought 4,200 tons of machine tools in the U. S. A. This import was very slow in reviving after the war. In the years immediately following the war hardly any took place at all. The deteriorated mark is not solely responsible for this fact, as not inconsiderable quantities of machine tools were bought in America with a worse mark than that of 1920. The truth is that the German machine building industry was during those years, the busiest of its post-war experience. As long as the inflation period lasted, German machine builders remained blind to outside developments, and it is significant that as soon as their eyes were opened the import of tools from the United States got into swing again.

A few figures may demonstrate this interesting fact. In 1920 the import of machine tools from the United States was 69 tons, or 7 per cent of the total of machinery imported. In 1922 the percentage of this country in the total ran up to 15.5 per cent. In 1923 the import dropped off, obviously due to the landslide of the mark. The stabilization of currency in 1924 brought about a rise of the imports from the United States to 278 tons, which in that year amounted to 24.5 per cent of the total. In 1925 the United States again occupies the leading position in Germany's machine tool imports, with a share in the total of 57 per cent, which is nearly the pre-war percentage. Taken ad valorem the imports from the United States may be estimated at about 9 million marks in 1925 in comparison to 8.9 million marks of the German grand total in 1913, in which sum the United States shared with 5.8 million marks. This reveals the fact that Germany has become a better customer for American machine tools than it used to be in the years immediately preceding the war.

The export business of German machine tools in 1925 showed a revival after the drop it experienced following the stabilization of the currency. In 1913 Germany exported 74,000 tons of machine tools valued at 81 million marks. This was then a record figure never achieved before. It was reserved to the first inflation year to exceed this figure. In 1920, for instance, 79,000 tons were exported. The real value of this export has, of course, never been ascertained and could not be, but it is safe to assume that it remained far behind that of pre-war times. In 1923 and 1924 the export dropped to about 35,000 tons. 1925 brought an increase to 45,000 tons, or about 60 per cent of the 1913 export. Taken ad valorem the export of 1925 was not as successful as in 1924. In 1913 the German export of machine tools averaged 1.10 marks per kg. The present average price is therefore about 56 per cent higher than in pre-war times.

Change in Type

As a further interesting fact it appears that the class of machinery exported has during the last years undergone a rather marked change. In 1913 the 106,500 individual pieces were exported, which makes an average weight of 700 kg. per piece. In 1923 the 35,600 tons of machine tools exported consisted of 115,000 pieces, and in 1924 a total 24,000 tons numbered no less than 128,000 pieces. The average weight per piece showed that the lightest kind of machinery formed the bulk of exports. In 1925 the average weight per piece rose to 490 kg., which still remains considerably below that of pre-war times. In some measure the reduced weight is due to the fact that German machine tool builders have, following the American lead, revised the dimensions of castings.

It is noticeable that in the case of a number of countries the export business is considerably less than in 1913. Foremost among them is Russia for obvious reasons, Austria-Hungary, France and Belgium, which are drawing upon German machine tools also under the Dawes plan, figures of which are not included in the exports. In a lesser degree also Denmark, Great Britain, Holland, Norway, Sweden, Japan. On the other hand, a number of countries have in 1925 bought more machine tools from Germany than in 1913. Most prominent among them are overseas countries, including the United States, Brazil, Argentine, India, Egypt; and of European countries Greece, Italy, Portugal, Roumania, Switzerland, Spain.

With regard to business prospects in the current year it can clearly be seen that German machine tool builders are straining every effort to raise their export returns even at a sacrifice in the way of prices. The pressure on the home market compels them to seek an outlet for their production.

As regards import, the movement of economizing production by new labor saving machinery has, of course, not come to a standstill and may be considered in its first part only. The best customer of the machine tool building industry, the motor car industry, has got into a deplorable state of financial stress and many manufacturing schemes in this connection had to be postponed on this account. There is no doubt that German industry will remain a good buyer of American special tools.

Arguments for and Against Tariff on Copper

Renewed agitation of the copper duty proposal by Senator Cameron, of Arizona, and Representative James, of Michigan, has created the impression that action on such legislation is imminent. Such is not the case. Those favoring this duty realize that they must muster additional support for the plan before they can hope for success.

Inquiries that are reaching Washington show that the interest in this matter is not confined to the United States. At least one foreign government has asked for information on the subject.

It is apparent that the proposition will have to overcome very strong opposition. One point made against it is that the effect will be much the same as that exerted by the Pittman act on silver production. In the effort to take advantage of the high price, mine capacity was developed which could not be supported normally and the industry is in a worse condition than it would have been had there been no temporary high prices.

It is argued that a tariff on copper would stimulate an industry that already is overdeveloped.

The reaction from the electrical industry is that there is more concern over getting the duty off of aluminum than there is over the possibility of a duty on copper. Were a duty imposed on copper substitution of other metals would be hastened, it is declared.

Birthday Dinner Tendered John Hays Hammond

Tributes from a host of friends, including many notable personages in this country and abroad, were paid to John Hays Hammond at a birthday dinner tendered him at the Waldorf-Astoria in New York on May 3. It was his seventy-first birthday that was celebrated.

On the committee of arrangements were many prominent citizens, among them John J. Carty, Chauncey Depew, Coleman du Pont, Arthur S. Dwight, Charles Dana Gibson, Simon Guggenheim, Arthur Twining Hadley, D. C. Jackling, George F. Kunz, James H. McGraw, Charles F. Rand, George Otis Smith, J. E. Spurr, and William Howard Taft.

Charles S. Thomas, former United States Senator from Colorado, was the toastmaster. Before introducing the first speaker he spoke briefly of Mr. Hammond. He had largely revolutionized mining conditions in the United States and the rest of the world, the Senator said. Today he was first among all engineers of this country and of the world—a publicist, historian, pioneer, capitalist, and statesman.

Senator Thomas then introduced Arthur Twining Hadley, president emeritus of Yale, and a classmate of Mr. Hammond's long ago. Fifty-five years ago, said Dr. Hadley, Hammond, a California boy, had sat with him in classes in prep. school and soon had won the regard of his instructors for the outstanding qualities which he displayed. Hammond was a man, he said, who translated his discoveries into action. Although now seventy-one years of age, he still had many years of good working activity remaining.

Secretary Davis, then speaking, said that he had known the guest of honor for twenty-five years. He told of an institution for the education and training of children, in the founding of which Mr. Hammond had assisted.

Following the Secretary, Dr. Alexander C. Humphreys, president of Stevens Institute of Technology, spoke. He came, he said, to honor a man among men, tried under many conditions, and able to meet them honorably and successfully. Mr. Hammond was one of the few to receive the degree of Doctor of Engineering from Stevens Institute, he said.

The toastmaster then introduced Key Pittman, Senator from Nevada. Drawing a comparison between the Senator and Mr. Hammond, he said that it was to Alaska instead of Germany that the Senator had gone to find *his* treasure.

Colonel Henry D. Lindsley, the next speaker, came as representative of that great body of Army and Navy men, he said, to pay tribute to the distinguished American who was the guest of honor. The war was won by two great bodies, the Army and Navy, he declared. They did their part. That part, however, would have been impossible had there not been in the United States an army of men and women no less devoted than those who wore the uniform. In that war, the speaker said, there was no man who set a more inspiring example than John Hays Hammond.

The guest of honor was then introduced. Mr. Hammond said that he should feel that he was lacking in the finer instincts if he were not overcome at such a demonstration. He felt more helpless than ever to try to express his gratitude. No wealth ever came out of a mine comparable to the friendship that made life worth living. Life was not to be regarded as a series of pleasure-giving incidents nor as a chance to play a good hand, but rather as an opportunity to play a bad hand well. He quoted Shaw to the effect that the real joy of life was in being used by a mighty purpose, realizing that it was a mighty one.

Thousands of messages paying tribute to Mr. Hammond were received, only a few of which were read. Congratulations were sent by President Coolidge. Chief Justice Taft expressed an admiration based on fifty years of close association. All these testimonials were presented to the guest of honor.

Chicago & North Western Operating Oil-Electric Locomotive

For switching service in the pier district on the North bank of the Chicago River, the Chicago & North Western Ry. has placed in operation a 60-ton, oil-electric locomotive, the joint product of the American Locomotive Co., the Ingersoll-Rand Co., and the General Electric Co.

The locomotive ran under its own power from Schenectady, N. Y., to Chicago at a cost, it is claimed, of $12.40 for fuel and lubricating oil for the 832 miles. It carries a fuel supply for 48 working hours and has a starting tractive power of 36,000 lb. at 30 per cent factor of adhesion.

H. J. Bailey Heads Jobbing Group

Henry J. Bailey, who resigned recently as vice-president of the Consolidated Machine Tool Corporation of America, of Rochester, N. Y., has been elected president and treasurer of the Supplies Securities Co., which has acquired a controlling interest in the Delaware Electric and Supply Co., 213 Shipley St., Wilmington, Del. Associated with Mr. Bailey in the company, which is a holding company, are: Charles C. Kurtz, Wilmer Stradley, Wilbur C. Jones and Earle C. Comegys.

The Delaware Electric and Supply Co. had its origin in a ship chandlery business, founded in 1856, by Homer and Francis Barry, which was developed and later purchased by George W. Stone. It now is capitalized at $200,000. The company is a jobber in plumbing supplies, millwork, steam fitters' supplies, machinery, boilers, pumps, ship chandlery, etc. Expansion is planned under the new ownership, chiefly along the line of heavy machinery, with which Mr. Bailey and Mr. Jones have long been connected. Both were for a long time connected with the Hilles & Jones Co., Mr. Bailey being president at the time the consolidation took place.

Atterbury Praises Employee Co-operation on Pennsy

In the annual report of the Pennsylvania Railroad which has just been forwarded to stockholders, W. W. Atterbury, president, discusses the relations between the company and its employees. Part of this report reads as follows:

"Evidence of increasing co-operation and a growing understanding of their mutual interests as between the management and employees is reflected in the improvement in your company's operations during the past year. The company values highly the results already realized through the operation of the Pennsylvania plan of employee representation.

"The essential aim of this plan was to promote the welfare of the employees, to assure them adequate representation in discussing with the management questions of wages and working conditions, and eventually to develop relations of such confidence that the management might be able to mobilize effectively the results in the improvement of every phase of the company's operations.

"Joint handling of labor questions through reviewing committees representing with equal power both management and men has thus come to be fundamental to the Pennsylvania Railroad policy.

Watson-Parker Bill a Step Forward

"It is gratifying that recognition has now been given in a bill pending before Congress to the desirability of just such methods of handling labor questions throughout the country. The proposed legislation, known as the Watson-Parker Bill, would repeal existing railroad labor legislation as expressed in the Transportation Act, and substitute for it a method of dealing with labor questions which holds promise of far more satisfactory results than anything which has yet been realized.

"This bill has been presented to Congress with the approval of an overwhelming number of the principal railroad executives of the country, and with the approval of the representatives of the employees.

"The proposed bill takes away from the Interstate Commerce Commission none of its present power to review proposals for increased freight rates or to take any other measures for the protection of the public interest against burdensome charges or conditions of any kind. The bill protects the public interest in every practicable way.

Urge Adoption of Bill

"In view, therefore of the present dissatisfaction with the labor provisions of the Transportation Act, and the promise the proposed legislation gives of placing the whole matter upon a new and better basis, your management has joined heartily with its own employees and with the management and the representatives of employees of other railroads in urging adoption of the proposed measure."

The Business Barometer

This week's outlook in Commerce, Finance, Agriculture and Industry based on current developments

By Theodore H. Price
Editor, *Commerce and Finance, New York*

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GREAT BRITAIN occupied the center of the stage last week, and the news from England entirely overshadowed a domestic situation that was in fact rather humdrum.

By their action in attempting to throttle the press and prevent the publication of the newspapers, the British labor leaders sacrificed the support of many who thought the coal miners were really underpaid. Therefore it is not surprising that the general strike subsequently ordered was regarded as a challenge by the British government or that it should have antagonized public opinion throughout the British Empire as well as in the United States. There can be no doubt of the outcome for a preponderant majority of the English-speaking peoples of the world are at heart individualistic and the trade unions have put their cause back for many years by their impolicy, in attempting to tie up all the vital services in Great Britain. Their defeat may take time, but it is certain and as this is written there are some indications that the labor leaders are already seeking a peace without victory.

Business in America has meanwhile marked time. The markets have not changed much and the fluctuations recorded are without special significance except in the case of cotton, where a crop scare that was based upon heavy rains in Texas seems to be in the making.

Futures are up nearly 45 points, and cotton goods were sympathetically firmer although the buying was in small lots and distributors are still skeptical of any important advance in prices.

Sugar has been dull but relatively steady and higher prices are generally expected when refiners and jobbers commence to appreciate the significance of the Cuban curtailment and the reduced estimates of next year's production that are gaining currency.

The grain markets remain hesitant and without significant trend. The reports from the steel industry are also confusing, but the best opinion seems to be that the demand is rather below the productive capacity.

This statement is in fact applicable to nearly every industry in the United States, including agriculture, and the problem of what some call "over-production" and others describe as "underconsumption" is becoming quite acute. Insofar as this country is concerned it is day by day being made plainer that we are at or near the maximum of our consumptive capacity until we develop new needs that will bring new industries into existence.

As a generalization it may be said that we have all the food that we can eat, and any surplus will be unmarketable unless an export demand for it can be found.

The same thing might be said of textiles. Most Americans have all the clothes they require, and any increase in the demand for cotton and woolen goods will be slow until we develop a foreign market for our surplus.

What's Doing in Industry

The apathetic condition of the present machine tool and machinery market has not shown any real signs of change. Business is running along at a sluggish pace, and is somewhat below what had been estimated for the period. Many reasons are given for the delays in placing orders for new equipment, but the one most apparent is the uncertainty of production schedules in major industries.

The New England territory continues to report a gain, export business having assumed an important part of present activity. New York dealers are holding a fair volume, with orders for special machines furnishing the bulk of business. Conditions in Buffalo are favorable for a good month. Inquiries in the Philadelphia district indicate good business pending.

The Mid-West, heretofore the leading market for business, has developed a spotty condition. Detroit business is below normal, but with the readjustment of the automobile industry a return to earlier estimates is expected. Chicago reports a satisfactory number of new inquiries, while Cleveland reports a variety of buying from many sections of the country.

Dealers and manufacturers in Cincinnati have had a quiet week and believe that more sales effort is needed to overcome present conditions. A fair amount of business is reported from Milwaukee where accessory manufacturers and railroads have placed orders for standard machines and fixtures.

Fundamental conditions in the country are sound and our resources are inexhaustible, but we are raising and making more things than we can consume and the future problem seems to be how to sell the excess outside of our own boundaries.

The automobile industry is in much the same situation. If it is to grow we must sell more cars abroad. It seems impossible that we can greatly increase the domestic use of motor-driven vehicles.

It is also evident that this country has pretty well caught up with itself in the construction of new buildings, new railroads and new ships.

In consequence many are now beginning to ask how we can fully employ the facilities for production with which we are provided.

There is no lack of purchasing power insofar as the money with which to buy is concerned, but people seem to have pretty much all they want and the rapid increase in the savings banks deposits and in the business of the life insurance companies shows that our national income is still in excess of our total expenditure for consumable things.

For the resulting surplus of capital it is hard to find investment unless it be used to create new productive facilities for whose output there will be no demand unless it can be sold abroad.

This predicament has been called "the dilemma of thrift." It is causing no little concern among the thoughtful. It explains the strength of the bond market, the steadiness of the stock market and the growing ease of money. But it is also causing many misgivings about the future because there is grave doubt of our ability to compete with Europe in supplying the world's needs unless we are able to reduce the cost of production by reducing wages and lowering the tariff.

This somewhat labored explanation of the economic maladjustment that is becoming so patent in the United States has been attempted in an effort to concentrate the minds of American business men upon the need of finding a way to increase the export demand for our surplus production.

Fundamental conditions here are sound. Our resources are inexhaustible. We have an abundance, if not a superabundance of capital and bank credit, but we are raising and making more consumable things than we need or want, and if we are to remain prosperous we must sell the excess outside of our own boundaries.

In continental Europe as in the United States, business has been slowed down by the British strike. French and Belgian francs have touched new lows of 3.09½ and 2.90 respectively. These are the lowest quotations thus far recorded. They are in part attributable to the fear that our Senate may refuse to ratify the proposed settlement of the French debt to this country.

The Industrial Review

Progress of the machinery and machine-tool business in various parts of the country

THE following reports, gathered from the various machinery and machine tool centers of the country, indicate the trend of business in these industries and what may be expected from the future:

Milwaukee

Developments in the metal-working equipment trade so far in May embrace many features that are encouraging to manufacturers and dealers. There are fairly substantial requirements before the trade, with the prospect of a continuance of buying on a moderate scale. Inasmuch as the business of local equipment manufacturers relates to the automobile industry in a relatively small measure, this market does not appear to have been affected to the same extent as some other producing centers by the slackening of the demand.

However, automobile shops are still doing considerable buying in single items for replacement or to promote efficiency. In several instances, large-lot needs of individual factories have not yet been fully met. In Milwaukee and vicinity the larger makers of automobile units, parts and accessories are actively in the equipment market. The A. O. Smith Corporation has been placing substantial orders for a large addition to the rear-axle housing department.

Various railroads, mainly Eastern lines, have placed moderate orders for milling machines in this market. Most of these are for standard tools. Milling machine builders have considerable work in hand on standard tools with a wide range of special fixtures, both for toolroom and production floors, and report a good call for special designs for quantity production of individual pieces.

Makers of internal grinders are still behind on deliveries, although as a rule, manufacturers of tools are quite well abreast of specifications. Working forces have suffered no decline; in fact, nearly all shops in the metal trades locally maintain standing orders with the employment office for all the skilled labor available.

Cleveland

The local machine tool market in general remains spotty but improvement was noted in several branches of the industry. The automatic machine and planer divisions report business for the past week as being exceptionally good and better than at any time in the last five weeks. This material increase has helped to banish any feeling of pessimism that had appeared recently.

Recent business included orders from steel plants, agricultural, gas fittings, railroads, automobile, wood- and metal-working manufacturers. The fact that inquiries are more numerous and general in scope is regarded as indicative of a better market in the near future.

Production has been slightly curtailed and several firms have reduced the night shifts. The punch and shear and used tool division is quiet.

Detroit

Little change has been noted in the business situation among machine tool and machinery dealers and manufacturers. The number of orders is below the average since the first of the year, but conditions are not at all alarming and most dealers feel that within the next 30 days activity in the automotive market centering in Detroit and other industrial plants in southeastern Michigan will be considerably greater than at the present.

There are general good times, speaking of Detroit as a whole, and automobile production has been maintained at a high level. Motor car sales have fallen off though, and the purchasing and engineering department are apparently intent on holding up orders for new equipment until sales resistance is broken. Some standard machines are being sold—milling machines, grinders and lathes, while small tools for the toolroom are finding a fair market.

Nothing big in the way of orders has fallen to the lot of any Detroit machinery dealer, however, and the immediate prospect is not as good as had been expected. Smaller dealers are having difficulty while the larger ones are finding competition much keener.

There is a market for good used machinery in Detroit but very little of that type is to be found at any price. Most of the buying is in single units, orders for two or more machines being few in comparison with those for individual units.

Buffalo

While reports from machine tool dealers here are by no means unanimous in their approval of the present condition of trade, there are some reports covering the April business and the indications for May that are rather favorable. Dealers, with a few exceptions, are in better humor over the trend of conditions than they were two weeks or a month ago.

The electrical equipment dealers are particularly busy. April proved to be as good in point of volume as the preceding months of the year, and better than April of last year.

The demand for contractors' equipment slowed up somewhat late in April, probably due to the cold and inclement weather preventing many contractors from beginning work as soon as they expected. However, it is expected that this condition is merely temporary and that business in this line will be good throughout the season as soon as warm weather arrives.

On the whole it may be said that the temper of the situation is slightly better than reported two weeks ago.

Philadelphia

Little change has been noted in the volume of business among machinery and machine tool manufacturers during the last two weeks. The forecast of some producers and dealers that sufficient orders were on hand and in sight to keep the plants in operation until early in July is now being proved correct.

Some new inquiries indicating that substantial orders may be forthcoming shortly have been received by dealers, but there is little upon which a forecast of heavy buying in the near future can be based.

One hopeful outlook is in the automobile buiness, where sales are ahead of what they were last year. Orders in other lines are not large. Small tool manufacturers and dealers report a brisk business, while dealers in used tools of all kinds say their business is about what it was at this time last year.

Cincinnati

The past week has been a quiet one in the Cincinnati machine tool market. However, manufacturers and selling agents regard it only as a seasonal lull which will be of short duration. A spirit of optimism prevails, all feeling confident that there is no danger of a depression.

Manufacturers are maintaining production as it has been, and there are sufficient orders on hand to keep the factories busy until more business can be booked. An increased selling effort, it is thought, is what is needed most at this time, as concerns that need tools badly, and must buy them sooner or later, can be induced to place their orders now.

Such orders as there have been in the past week were well scattered over the country and were well diversified as to sizes and types. Inquiries continued to come in from all sections, and this fact gives more than a grain of comfort, as it is a clear indication of the need of tools.

Shipments made in the week consisted principally of single tools, most of which were for replacement purposes, ordered by concerns in various branches of the metal industries and by industrial users. A few shipments were made to automotive concerns.

New England

Export business of New England Machinery manufacturers will show an increase of more than 50 per cent this year over 1925, if the present volume is maintained for the rest of the year. Japan, Germany, France, Italy and South American countries are buying machinery in the New England territory in better volume. The demand for automatic production equipment is increasing, especially as American made products are adapted.

There does not appear to be any indication of a slowing up of business. The inquiry mail is large, disclosing that the rest of the year will furnish plenty of trade. Occasionally, there have been periods of hesitation about placing orders, but eventually the business is booked and heads of plants are confident that 1926 is going to stand as a good year for the industry. The buying at the present time is of a broader character without any particular industry standing out conspicuously.

Dealers in used machinery report a steady demand, especially for small equipment for garages.

New York

Scattered orders for single machines of special design have helped to hold up the volume of business in this market in the past week. There have been no large orders placed, but inquiries received indicate a paper activity that is expected to materialize into good business before the end of the month. Railroads, public utilities and large industrial plants are listed as prospective buyers of equipment.

Despite the current reports that business has slacked off, a partial list of the machines sold in the past ten days shows that there is a fair amount of business being done. This list includes: Two large side-head boring mills, two 42 ft. x 18-in. lathes, two 36 ft. x 18-in. lathes, one 36 x 12-ft. planer, one 96 in. x 18-ft. planer, three automatic lathes, one jib borer, one vertical shaper, five hand millers, two thread milling machines, three automatic milling machines and an automatic centering machine. Much small shop equipment was also moved.

Buyers included the Otis Elevator Co., the Pennsylvania Railroad, the Baldwin Locomotive Works, the Chicago, Rock Island & Pacific R.R., and the General Electric Co.

Chicago

While reports from large handlers of metal working machine tools are not such as to indicate that the machinery market is developing a trend toward activity, they are of a nature that may be called encouraging. The month of May opens with the prospect that, as it advances, business will improve. It is agreed among machinery men who make a study of nation-wide industrial conditions that the slump in business experienced during the last few weeks is abnormal and unaccountable, but that it cannot prevail for any considerable period.

Inquiries continue to be received in satisfactory number, and the closing of several large and important sales is looked for in the near future. Railroads are making inquiry for tools needed for equipment purposes, which, as one dealer put it, they must of necessity buy if they expect to keep their shops going on full time. In the line of grinding machinery and abrasives, no decrease in business has been shown at any time this year, and from the present outlook none is expected.

Consensus of opinion among the trade is to the effect that as the year advances there will be a revival of business, and that the first half of this year will average up to, if it does not exceed, that of the same period of last year.

Enlist Aid of School in Apprentice Training

Many are the reasons which management often gives for not training apprentices. The district co-operative plan established by the International Correspondence Schools offers a solution to these problems. Milwaukee first demonstrated its merit. Now the plan is to be tested by Moline, East Moline, Rock Island, Davenport and their suburbs. Last March, the Tri-City Manufacturers' Association and the Quad City Foundrymen's Association agreed to launch such a program, and to use the resources of the I.C.S.

In April, H. A. Frommelt, consultant of the apprentice training division of the I.C.S., with his staff established headquarters in Moline. These specialists will make a survey of the various plants in the Quad Cities to enable them to draw up the necessary programs of training (consisting of shop and school schedules) suitable for individual plants or groups of plants. These schedules will be incorporated into suitable apprentice indentures. The necessary machinery will also be organized and put into operation that the program may become a reality.

Business Items

The Tulley Equipment Co., of St. Louis, sales agent for the Climax Engineering Co. in that territory, has moved to 2339 Pine St.

The Graybar Electric Co. has made plans for the establishment of branch offices at Reading, Pa., Dayton, Ohio, and Hartford, Conn.

Percy M. Brotherhood & Son has been organized with offices at 25 Church St., New York, and a branch office at 415 Elmwood Ave., Buffalo, N. Y.

The Standard Gage Co., Inc., of Poughkeepsie, N. Y., announces the opening of a Western sales office at 4829 Woodward Ave., Detroit.

The Knoxville, Tenn., office of the Sullivan Machinery Co., of Chicago, has moved from 614 Market St. to the General Bldg., at 623 Market St. E. L. Thomas continues as manager.

D. C. Oviatt & Co., of Cleveland, Ohio, dealers in new and used machinery, have moved their offices from 1196 St. Clair Ave. to 2160 Lakeside Ave., adjacent to the warehouse.

The Monarch Machine and Manufacturing Co., of Greensboro, N. C., manufacturer of woodworking equipment, recently purchased the plant and equipment of the W. J. Westbrook Elevator Co., of Greensboro, and is using the plant as an addition to the Monarch factory.

The Bonney Forge and Tool Works, of Allentown, Pa., announces the appointment of the following sales representatives: Ronald Wixson will cover Florida, Georgia, North Carolina, South Carolina, and the Virginias; I. K. Fox will cover Colorado, Kansas, and part of Louisiana, Arkansas, New Mexoco, Oklahoma and Texas.

The A. & F. Brown Co., engineers, founders and machinists, announces the removal of its sales department and stockroom to the general offices and works at Elizabethport, N. J. The old New York office at 79 Barclay St. will be discontinued, but the usual deliveries will be made under new arrangements in New York and vicinity.

The National Acme Co., of Cleveland, Ohio, announces the following changes in its personnel: J. I. Burgess has been appointed to handle machine tool sales in Ohio, Kentucky and West Virginia; H. S. Mitchell has been appointed purchasing agent for the company; W. G. Furlong has been appointed sole agent for the company's product in the Buffalo territory.

J. Barraja-Frauenfelder & Co. has been organized with offices at 8-10 Bridge St., New York City, to engage in consulting and advisory engineering service on oil engines and their application to industries. The advisory and executive staff includes: Rear Admiral Charles W. Dyson, retired, W. V. Naulty, J. Barraja-Frauenfelder, Heinrich Schneider, Edward C. Madgeburger, H. H. Wilkinson and Roger A. McShea.

Personals

C. H. JOHNSON and F. W. COOMBS have been elected vice-presidents of the Gisholt Machine Co., of Madison, Wis.

PROFESSOR COLLINS P. BLISS has been appointed associate dean of the College of Engineering of New York University.

HERBERT E. MILLS has been appointed production manager for the new plant of the Amplion Corporation of America, New York.

F. K. GLYNN of the American Telephone and Telegraph Co., has been elected chairman of the Metropolitan Section of the Society of Automotive Engineers.

N. R. BROWNYER has been appointed motor coach engineer for the Kelly-Springfield Truck and Bus Corporation, of Springfield, Ohio. He was formerly chief engineer for the Gotfredson Corporation.

J. McA. DUNCAN, for the past fifteen years Pittsburgh district manager for the Westinghouse Electric and Manufacturing Co., has been appointed assistant general sales manager of the company.

M. H. STARR has resigned as experimental engineer with the E. & T. Fairbanks Co., of St. Johnsbury, Vt., and has become chief engineer for the Howe Scale Co., of Rutland, Vt.

WILLIAM R. TOMLINSON has been appointed vice-president and factory manager for the Billings & Spencer Co., of Hartford, Conn. Mr. Tomlinson was until very recently associated with the Pratt & Whitney Co.

JOHN A. CAMM has been appointed sales representative in the Chicago territory for the Seneca Falls Machine Co., of Seneca Falls, N. Y. Mr. Camm was formerly sales manager for the Kearney & Trecker Corporation.

FRED EBERHARDT, of the firm of Gould & Eberhardt, manufacturers of gear cutting machines and shapers, of Newark, N. J., sailed on April 28 for an eight-weeks' business and pleasure trip through continental Europe.

W. SCOTT THOMAS has been appointed special foundry equipment sales representative in New England for the Northern Engineering Works, of Detroit. Mr. Thomas has established offices at 316 National Exchange Bank Bldg., Providence, R. I.

MARCUS A. CURRAN, manager of the central station department of the Graybar Electric Co., has been appointed assistant to the vice-president of the organization. George F. Hessler, manager of the line material sales department, has been appointed general utility sales manager.

H. KEMPNER has been appointed sales manager of the "Lo-Hed" electric hoist division of the American Engineering Co., of Philadelphia. Mr. Kempner has been associated with this company for the past three years as manager of sales promotion and advertising.

C. S. STOUFFER has resigned as works engineer for the Kewanee Plant of the Walworth Co., and has accepted a similar position with Stanley G. Flagg & Co., of Stowe, Pa. Mr. Stouffer had been associated with the Walworth Co. for several years as mechanical engineer, chief draftsman and works manager.

News of the Automotive Industry

A detailed estimate of Ford's business in 1925 indicates that the actual profit a car realized by Ford Motor Co. from sales was $29 against $40 in 1924. The decline in profits is largely accounted for by the company's production difficulties in August and September when the new models were brought out. The estimate is worked out from the increase in surplus shown in the Ford balance sheet during the past year.

Figures given out by President E. G. Wilmer, of Dodge Brothers, Inc., show that retail buying of the company's cars and trucks throughout the United States has reduced retail dealers' stocks of cars available for delivery to the low average of less than three per dealer. "As of April 24, the Dodge Brothers dealers in the United States had on hand 26,921 new cars and trucks against which they held 17,568 signed orders from customers," said Mr. Wilmer. "Spread the difference of 9,353 over an organization of 3,300 dealers and you realize how small their stock really is."

Hudson-Essex production for April is officially stated to have been over 24,000 cars, which brings the 1926 total to May 1 to 92,500, or about 19,000 more cars than in the corresponding period of 1925. This represents an increase above last year of over 25 per cent.

General Motors Corporation is preparing to absorb the minority interest in the Fisher Body Corporation. The parent company, which holds a little more than 60 per cent of Fisher Body, seeks the remaining stock interest on a basis of one share of General Motors for one and a half of Fisher Body. General Motors has long been a majority holder in Fisher Body. The management of the former corporation has been ambitious for some time to acquire the Fisher business in entirety. The difficulty thus far has been in reaching an understanding with the Fisher Body company's principal holders, W. A. Lawrence, Charles T., E. F. and A. J. Fisher.

The total consumption of copper by the automobile industry last year amounted to over 245,000,000 lb., a record figure, it is estimated by the Copper and Brass Research Association. The increase in both production and registration of motor vehicles caused a further increase in the amount of copper consumed by the industry. The growing preference for closed car models has increased the copper requirements for lighting systems, brass body hardware and trim.

Obituaries

CHARLES H. COIT, founder of the Cleveland Stamping and Tool Co., of Cleveland, Ohio, died in that city on April 27. He was 62 years old.

CHARLES E. GILES, consulting engineer and an authority on steam engineering, died at his home in Providence, R. I., on May 9. He was a life member of the American Society of Mechanical Engineers.

LEWIS G. KECK, secretary and treasurer of the Bickford Drill and Tool Co., and later traffic manager for the Cincinnati Bickford Tool Co., died on April 19 in Cincinnati. He had been associated with these firms for thirty-five years.

THOMAS WRIGLEY, president of the Thomas Wrigley Co., died in Chicago on April 27 at the age of 91. Mr. Wrigley came to Chicago from Paterson, N. J., in 1868 and entered the service of the Crane Manufacturing Co., becoming foreman of the machine department. A year later he founded the firm with which he has since been identified.

FRANK E. GREENE, until recently general superintendent of the Franklin Machine Co., of Providence, R. I., died at his home in that city last month. Mr. Greene was well-known in the machinery industry, having served in executive capacities at different times with the Corliss Steam Engine Co., the Westinghouse Machine Co., the Fairbanks-Morse Manufacturing Co., the Hendey Machine Co., and the Franklin Machine Co.

What the Railroads Are Doing

The Lima Locomotive Works has received an order for 10 six-wheel switching engines from the Union Railway of Pittsburgh.

The Delaware, Lackawanna & Western Railroad Co., has placed an order with the American Locomotive Co., for 25 heavy mountain-type, three-cylinder freight locomotives.

The Southern Railway system has awarded contracts for 45,200 tons of 39-ft., 100-lb. steel rail for delivery during the latter part of the year. The largest share of the order, 38,600 tons, was given to the Tennessee Coal, Iron and Railroad Co., rails to be fabricated at Ensley, Alabama, plant. The rest of the order was divided, 4,600 tons to the Bethlehem Steel Co., and 2,000 tons to the Illinois Steel Co. the order is sufficient to relay 650 miles of track. This order is in addition to 46,200 tons ordered for delivery in the first half of 1926, making a total of 91,400 tons this year.

Among equipment orders placed last week were 1,000 gondolas for the Atlantic Coast Line, ordered from the American Car and Foundry Co., and 500 steel underframes for the Southern, from Tennessee Coal, Iron and Railroad Co.

The Northern Pacific is in the market for 12 mountain-type locomotives.

The American Locomotive Co. has received orders for 5 mountain-type locomotives for the Sorocabana Railway, of Brazil, and one switcher for the Fonda, Johnstown & Gloversville.

The Baldwin Locomotive Works has booked one Mikado engine for the C. R. McCormick Lumber Co.

Stockholders of the Railway Steel Spring Co. have approved the plan to amalgamate the company with the American Locomotive Co., under terms recently proposed by directors of both concerns. The plan, in substance, provides for the absorption by the American Locomotive of the Railway Steel Spring and the exchange of stocks in the companies.

The Atlantic Coast Line has placed an order for 1,000 composite gondolas with the American Car and Foundry Co. An order for 500 flatcar underframes has been placed by the Southern Railway with the Tennessee Coal, Iron and Railroad Co.

The Sinclair Refining Co. has ordered fifty tank cars from the General American Tank Car Corporation. An inquiry for 200 underframes has been sent out by the Rock Island, while the Erie has revived an inquiry for twenty-seven passenger underframes.

The Poole Engineering and Machine Co. has been awarded a contract for locomotive boosters aggregating $1,250,000. This order is in addition to one for $1,250,000 on which the company has been working for the last three months.

The new order and other orders on hand will keep this division of the plant in operation throughout the year. Other divisions of the plant are being made ready to go into full operation.

The Union Pacific R.R. Co. has added to its line of motive power what is said to be the largest single-boiler locomotive in the world, to haul trains of perishable fruit over the Continental Divide. It will make 50 miles an hour, hauling a train a mile long. The locomotive has three cylinders, is 102 ft. long, 16 ft. high, 11 ft. wide, and weighs 782,000 lb. The unit was designed by officials of the Union Pacific.

Authority to assume liability for $1,020,000 of equipment trust certificates has been granted by the Interstate Commerce Commission to the Minneapolis, St. Paul & Sault Ste. Marie Railway Co. This amount is to apply on the purchase of five hundred 40-ton steel-frame box cars at $2,091.60 each; one hundred 50-ton steel-frame gondola cars at $2,193.56 each; 2 steel-frame cafe-parlor cars at $53,681.41 each.

Outlook for the American Locomotive for the first half is satisfactory. Earnings for the first quarter were sufficient to cover the dividend for the period. American Locomotive went into the second quarter with something like $20,000,000 of business on its books, and it is likely that a 50 per cent rate of operations will be maintained until some time in the third quarter, even if no new business were to develop.

Calendar of Local Meetings

National Association of Cost Accountants

Philadelphia. May 14. The Training of Supervisory People. Reduction of Cost in Keeping Labor Turnover at a Minimum.

Mohawk Valley. May 17. Plant inspection and visit to a manufacturing plant at Ilion, N. Y. The Company's Cost Methods and the Uses Made of Its Cost Records.

Hartford. May 18. Annual ladies' night for members and their ladies.

Los Angeles. May 18. How a Cost System Can Reduce Costs. Standard Costs Compared with Actual Costs. Accounting machine demonstration.

Twin Cities. May 18. Trucking Cost Problems—Owned vs. Hired Trucks.

Cleveland. May 19. Distribution and Marketing. Rate Setting and Time Study.

Pittsburgh. May 19. Manufacturing Budgets or the Content of a Course in Cost Accounting.

Syracuse. May 19. "Practical Uses of Standard Costs," by Eric A. Camman; Peat, Marwick, Mitchell & Co., New York.

Chicago. May 20. The Relation of Cost Accounting in Industrial Planning.

Milwaukee. May 21. Election of officers. What Are the Functions of the Cost Department from the Executive's Point of View?

San Francisco. May 24. Signs of Progress in Cost Accounting.

Scranton. May 25. "The Pennsylvania Corporation Taxes," by P. A. Kennedy, Pennsylvania Corporation Tax Office.

Boston. May 27. "Cost Accounting vs. Industrial Relations," by Frank J. Dunleavy; The Dunleavy Company.

American Society for Steel Treating

Hartford. June. Spring sectional meeting.

Society of Automotive Engineers

Southern California Section. May 14. "Improvements Needed in Motor Vehicles to Render Them More Efficient, and What I Consider the Most Recent Great Improvement," by F. D. Howell, Eugene Power, P. H. Decker, Wm. H. Fairbanks, R. W. Stewart, Donald W. Douglas and J. J. Canavan.

Chicago Section. May 17. "Gasoline Substitutes from Coal," by A. C. Fieldner.

Buffalo Section. May 18. "Coincidental Locks," by C. B. Veal.

Detroit Section. May 20. "Coincidental Locks," by C. B. Veal.

Metropolitan Section. May 20.

American Society of Mechanical Engineers

Cleveland. May 14. Afternoon session of Chemical Week. Subject: "The Use of Rubber Lining in Grinding Machinery," by B. W. Rogers.

Atlanta. May 20. Luncheon meeting and visit to plants of the Standard Products Co., the Liquid Carbonic Co. and the Linde Air Products Co.

Buffalo. May 25. Regular meeting. Speaker: Mrs. Lillian Gilbreth.

Portland. May 22. At University Club, Portland, Oregon. "Modern Locomotives," Speakers—Rupen Eksergian and A. T. Beuter.

Cincinnati. May 28. "Mass Production and Its Effect on Machine Tool Design," by Arthur C. Pletz, Morris Tool Co.

Western Washington. May 29. At Longview, Washington. Demonstration of city planning system, with visit to local Long-Bell Mills.

Forthcoming Meetings

American Gear Manufacturers' Association. Tenth annual meeting, Book-Cadillac Hotel, Detroit, May 13, 14 and 15. T. W. Owen, secretary, 2443 Prospect Ave., Cleveland, Ohio.

American Supply and Machinery Manufacturers' Association. Annual convention, Hotel Statler, St. Louis, week of May 17. F. D. Mitchell, secretary, 1819 Broadway, New York.

American Iron and Steel Institute. Spring meeting, Hotel Commodore, New York, May 21. E. S. Clarke, secretary, 40 Rector St., New York.

Associated Machine Tool Dealers. National convention, French Lick Springs Hotel, French Lick, Ind., May 20, 21 and 22. T. W. Carlisle, Strong, Carlisle & Hammond Co., Cleveland, is secretary.

National Association of Foremen. Annual convention, Springfield, Ohio, May 25. V. H. Whipple, secretary, c/o Y. M. C. A., Dayton, Ohio.

Society of Automotive Engineers. Summer meeting, French Lick Springs, Indiana, June 1 to 4. John Warner, manager of meetings, S. A. E., 29 West 39th St., New York City.

Iron and Steel Exposition. Annual exhibit of fuel, electricity, machinery and safety under the auspices of the American Society for Steel Treating, Hotel Sherman, Chicago, June 7, 8, 9 and 10. Secretary, W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

National Association of Purchasing Agents. Eleventh annual convention and exposition, Ambassador Hotel and Auditorium, Los Angeles, Calif., June 9 to 12. W. L. Chandler, secretary, Woolworth Bldg., New York.

American Railway Association. Annual meeting of the Mechanical Division (Master Car Builders and Master Mechanics), Atlantic City, N. J., June 9 to 16. V. R. Hawthorne, secretary, 431 So. Dearborn St., Chicago.

Railway Supply Manufacturers' Association. Annual convention and exhibit in conjunction with Division V, Mechanical, of the American Railway Association, Young's Million Dollar Pier, Atlantic City, June 9 to 16. J. D. Conway, secretary, 1841 Oliver Bldg., Pittsburgh.

Society of Industrial Engineers. Thirteenth national convention, Bellevue-Stratford Hotel, Philadelphia, June 16, 17 and 18. Executive secretary, George C. Dent, 608 S. Dearborn St., Chicago.

American Society for Testing Materials. Haddon Hall Hotel, Atlantic City, N. J., June 21 to 25. C. L. Warwick, secretary, 1315 Spruce St., Philadelphia.

American Society of Mechanical Engineers. Spring meeting, Palace Hotel, San Francisco, Calif., June 28 to July 1. Chairman of convention, Warren H. McBride, the California and Hawaiian Sugar Refining Co., 215 Market St., San Francisco.

American Railway Tool Foremen's Association. Annual convention, Hotel Sherman, Chicago, Sept. 1, 2 and 3. G. G. Macina, secretary, 11402 Calumet Ave., Chicago.

American Railway Tool Foremen's Supply Association. Annual exhibit in connection with the annual convention of the American Railway Tool Foremen's Association, Chicago, Sept. 1, 2 and 3.

Machine Tool Exhibit. Sixth annual exhibition of machine tools at the Mason Laboratory, Yale University, under the auspices of the New Haven Section, A.S.M.E., the mechanical engineering department of the Sheffield Scientific School, and the New Haven Chamber of Commerce, Sept. 7 to 10. Administrative office, New Haven Machine Tool Exhibit, 400 Temple St., New Haven, Conn.

The Weekly Price Guide

Rise and Fall of the Market

THE price trend is definitely downward in pig iron; buying continues slow. Steel sheets, black and galvanized particularly, show a declining tendency at mills. Cold-rolled strip steel is lower than a week ago. Considerable firmness prevails in the principal hot-rolled products, bars selling at $2 per 100 lb., Pittsburgh, shapes, $1.90@$2 and plates, $1.90, f.o.b. mills. Recent declines in non-ferrous metals are reflected in a drop of ⅛c. per lb. in solder and ⅛ to ¼c. per lb. in babbitt metal, compared with the Mar. 27 levels. Linseed oil is quoted at 11.3c. per lb. in 5 bbl. lots, f.o.b. New York, against 11.5c., Apr. 29, 1926.

(All prices as of May 7)

IRON AND STEEL

PIG IRON—Per gross ton, f.o.b.:

CINCINNATI	
No. 2 Southern	$24.05
Northern Basic	24.27
Southern Ohio No. 2	24.27
NEW YORK—Tidewater Delivery	
Southern No. 2 (silicon 2.25@2.75)	28.37
BIRMINGHAM	
No. 2 Foundry	22.00
PHILADELPHIA	
Eastern Pa., No. 2x (silicon 2.25@2.75)	23.76
Virginia No. 2	29.17
Basic	22.76
CHICAGO	
No. 2 Foundry local	23.00
No. 2 Foundry, Southern (silicon 2.25@2.75)	26.55
PITTSBURGH, including freight charge ($1.76) from Valley	
No. 2 Foundry	21.27
Basic	21.27
Bessemer	21.27

IRON MACHINERY CASTINGS—Cost in cents per lb. of 100 flywheels, 6-in. face x 24-in. dia., hub not cored, good quality gray iron, weight 275 lb.:

Detroit	5.00@5.25
Cleveland	5.00@5.25
Cincinnati	5.00@5.50
New York	5.25@5.50
Chicago	5.25@5.75

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the mill base in large lots.

Blue Annealed	Pittsburgh Mill Base	New York	Cleveland	Chicago
No. 10	2.45@2.50	3.89	3.25	3.50
No. 12	2.50@2.55	3.94	3.30	3.55
No. 14	2.55@2.60	3.99	3.35	3.60
No. 16	2.65@2.70	4.09	3.45	3.70
Black				
Nos. 18 to 20	3.05@3.15	4.30	3.90	3.90
Nos. 22 to 24	3.10@3.20	4.35	3.95	3.95
Nos. 26 and 27	3.15@3.25	4.40	4.00	4.00
No. 28	3.25@3.35	4.50	4.10	4.10
Galvanized				
No. 10	3.50@3.60	4.65	4.25	4.25
Nos. 12 to 14	3.60@3.70	4.75	4.35	4.35
No. 16	3.75@3.85	4.90	4.50	4.50
Nos. 18 to 20	3.90@4.00	5.05	4.65	4.65
Nos. 22 to 24	4.05@4.15	5.20	4.85	4.80
Nos. 26 and 27	4.20@4.30	5.35	5.10	4.95
No. 28	4.50@4.60	5.65	5.25	5.25

WELDED STEEL PIPE—Warehouse discounts are as follows:

	New York Black	New York Galv.	Cleveland Black	Cleveland Galv.	Chicago Black	Chicago Galv.
1 to 3 in. steel butt welded	53%	39%	55½%	43½%	58%	45%
2½ to 6 in. steel lap welded	48%	35%	53½%	40½%	55%	42%

Malleable fittings: Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 36-5% off.

Size, Inches	List Price per Foot	Diameter in Inches — External	Diameter in Inches — Internal	Thickness Inches
1	$0.17	1.315	1.049	.133
1¼	.23	1.66	1.38	.14
1½	.27½	1.9	1.61	.145
2	.37	2.375	2.067	.154
2½	.58½	2.875	2.469	.203
3	.76½	3.5	3.068	.216
3½	.92	4.0	3.548	.226
4	1.09	4.5	4.026	.237
4½	1.27	5.0	4.506	.247
5	1.48	5.563	5.047	.258
6	1.92	6.625	6.065	.28

SEAMLESS STEEL TUBING—Following net prices are for seamless mechanical tubing, cold drawn, round, .10 to .30 carbon, at warehouse in lots of less than 100 ft.:

Thickness — Decimal	B.W.G. and Fractions	Outside Diameter in Inches ⅛	¼	⅜	½	1	1½	1¼
		Price per Foot						
.035″	20	$0.15	$0.16	$0.17	$0.18	$0.19	$0.21	$0.23
.049″	18	.17	.18	.19	.20	.21	.23	.25
.065″	16	.19	.20	.21	.22	.23	.25	.27
.083″	14	.20	.22	.23	.24	.25	.27	.29
.095″	13	.21	.23	.25	.26	.27	.29	.31
.109″	12	.22	.24	.26	.27	.28	.30	.32
.120″ or .125″	11	.23	.25	.27	.28	.29	.31	.33
.134″	10	.24	.26	.28	.29	.30	.32	.34

MISCELLANEOUS—Warehouse prices in cents per pound in 100-lb. lots:

	New York	Cleveland	Chicago
Spring steel (light) (base)*	7.00	6.00@7.50	4.65†
Spring steel (heavier)	4.00	....	4.00
Coppered Bessemer rods (base)	6.05	6.00	6.20
Hoop steel	4.49	3.65	4.15
Cold rolled strip steel	6.25	6.35	6.25
Floor plates	5.25	5.30	5.00
Cold drawn shafting or screw	4.00	3.90	3.60
Cold drawn flats, squares	4.50	4.40	4.10
Structural shapes (base)	3.34	3.10	3.10
Soft steel bars (base)	3.24	3.00	3.00
Soft steel bar shapes (base)	3.24	3.00	3.10
Soft steel bands (base)	3.99	3.20	3.65
Tank plates (base)	3.34	3.20	3.10
Bar iron (3.00 at mill)	3.24	3.21	3.00
Drill rod (from list)	60@65%	55%	50%

Electric welding wire, New York, ⅜, 8.25c.; ⅛, 7.85c.; 1/32 to ⅛, 7.35c. per lb. *Flat, 1/16@¼-in. thick. †F.o.b. cars.

METALS

Current Prices in Cents Per Pound

Copper, electrolytic (up to carlots), New York	15		12½
Tin, 5-ton lots, New York	66.50		
Lead (up to carlots) E. St. Louis	7.65	New York	8.50
Zinc (up to carlots) E. St. Louis	6.80	New York	7.62½

	New York	Cleveland	Chicago
Antimony (Chinese), ton spot	17.00	21.50	16.00
Copper sheets, base	22.50	22.50	22.50
Copper wire, base	19.25	16.50	16.00
Copper bars, base	22.12½	22.12½	21.87½@22.12½
Copper tubing, base	24.25	24.25	24.25
Brass sheets, base	18.87½	18.87½	18.87½
Brass tubing, base	23.50	23.50	23.50
Brass rods, base	16.62½	16.62½	16.62½
Brass wire, base	19.37½	19.37½	19.37½

Shop Materials and Supplies

METALS—Continued

	New York	Cleveland	Chicago
Aluminium ingots, 98 to 99%, 1 to 15 ton lots	27.00	27.00	27.02
Zinc sheets (casks)	12.00	12.60@12.95	12.27
Solder (½ and ½), (case lots)	39.50	42.00	38½@42½

Babbitt metal, delivered, New York, cents per lb.:

Genuine, highest grade	80.87½
Commercial genuine, intermediate grade	56 00
Anti-friction metal, general service	23.50
No. 4 babbitt (f.o.b.)	13.62½

Nickel, f.o.b. refinery, cents per lb.:

Ingots	31 00	Electrolytic	38.00
Shot	32.00		

SPECIAL NICKEL AND ALLOYS—Price in cents per lb., f.o.b. Huntington, W. Va.:

Hot rolled nickel sheet (base)	52.00
Cold rolled nickel sheet (base)	60.00
Hot rolled rods, Grade "A" (base)	50.00
Cold drawn rods, Grade "A" (base)	58.00
Manganese nickel hot rolled rods "E"—low manganese (base)	54.00
Manganese nickel hot rolled rods "D"—high manganese (base)	57.00

Base price of Monel metal in cents per lb., f.o.b. Huntington, W. Va.:

Shot	32.00	Hot rolled rods (base)	40.00
Blocks	32.00	Cold drawn rods (base)	48.00
Ingots	38.00	Hot rolled sheets (base)	42.00
Cold rolled sheets (base)			50 00

OLD METALS—Dealers' purchasing prices in cents per pound:

	New York	Cleveland	Chicago
Crucible heavy copper	11.75@12.25	11.25	10.75@11.25
Copper, heavy, and wire	11.00@11.75	11.50	10.25@10.75
Copper, light, and bottoms	9.50@10.00	9.75	9.50@10.00
Heavy lead	6.75@ 7.00	6.50	6.25@ 6.75
Tea lead	4.75@ 5.00	5.00	5.00@ 5.50
Brass, heavy, yellow	7.25@ 7.50	7.25	7.00@ 7.50
Brass, heavy, red	9.25@ 9.75	9.50	8.25@ 8.75
Brass, light	6.00@ 6.25	6.00	6.25@ 6.75
No. 1 yellow rod turnings	8.25@ 8.50	8.00	7.50@ 8.00
Zinc	4.50@ 4.75	4.00	4.00@ 4.50

TIN PLATES—American Charcoal—Bright—Per box

		New York	Cleveland	Chicago
"AAA" Grade:				
IC,	14x20	$12.10	$11.45	$11.50
"A" Grade:				
IC,	14x20	9.70	9.40	9 50
Coke Plates—Primes—Per box				
100-lb.,	14x20	6.45	6.10	7.00
Terne Plates—Small lots, 8-lb. Coating—Per box				
IC,	14x20	7.75@8.00	6.95	7.50

MISCELLANEOUS

	New York	Cleveland	Chicago
Cotton waste, white, per lb.	$0.13@0.17½	$0.18	$0.15@0.20
Cotton waste, colored, per lb.	.10@ .14	.17	12@.17
Wiping cloths, washed white, per lb	.18	36.00 per M	.16
Sal soda, per 100 lb. keg	2.05	2.25	2.75*
Roll sulphur, per 100 lb	3.60†	3.35	4.25‡
Linseed oil, per gal., 5 bbl. lots	.84½	.96	.87
Lard cutting oil, 25% lard, per gal.	.55	.50	.48
Machine lubricant, medium-bodied (55 gal. metal bbl.), per gal.	.35	.35	.29
Belting—Present discounts from list in fair quantities (½ doz. rolls).			
Leather—List price, 24c. per lin. ft. per inch of width for single ply.			
Medium grade	40–5%	40–5%	40–5%
Heavy grade	30–10%	30–10%	30–10%
Rubber transmission, 6-in., 6 ply, $1.83 per lin. ft.			
First grade	50%	50–10%	50%
Second grade	50–10%	60–5%	50–10%

*In 175 lb. kegs. † Per 150 lb. lot. ‡In 425 lb. barrels

Comparative Warehouse Prices

New York	Unit	Current Price	Four Weeks Ago	One Year Ago
Soft steel bars	per lb.	$0.0324	$0.0324	$0.0324
Cold drawn shafting	per lb.	.04	.04	.0415
Brass rods	per lb	.1662½	.1662½	.1587½
Solder (½ and ½)	per lb.	.395	.4012½	.395
Cotton waste	per lb.	.13@.17½	.13@.17½	15@22
Washers, cast iron (½ in.)	per 100 lb.	7.00	7.00	7.00
Emery, disks, cloth, No. 1, 6 in. dia.	per 100	3.55	3.55	3.38
Lard cutting oil	per gal.	.55	.55	.60
Machine oil	per gal.	.35	.35	.33
Belting, leather, medium	off list	40–5%	40–5%	30–10%
Machine bolts up to 1x30 in.	off list	40%	40%	40%

MISCELLANEOUS—Continued

	New York	Cleveland	Chicago
Abrasive materials—In sheets 9x11 in., No. 1 grade, per ream of 480 sheets:			
Flint paper	$5.56	$5.84	$5.65
Emery paper	10.71	11.00	10.71
Emery cloth	29.48	31.12	29.48
Emery disks, 6 in. dia., No. 1 grade, per 100:			
Paper	1.49	1.45	1.49
Cloth	3.55	3.55	3.20
Fire clay, per 100 lb. bag		.60	.75
Coke, prompt furnace, Connellsville	per net ton		3 00@ 3.15
Coke, prompt foundry, Connellsville	per net ton		4.25@ 4.75
White lead, dry or in oil	100 lb. kegs	New York, 15.25	
Red lead, dry	100 lb. kegs	New York, 15.25	
Red lead, in oil	100 lb. kegs	New York, 16 75	

SHOP SUPPLIES

Machine bolts, ¼x1½-in., per 100, $1.70. Discount at New York warehouses on all sizes up to 1x30-in., 40%; 1¼ and 1¼x3-in. up to 12-in., 15%; with cold punched hex. nuts up to 1-in. dia. (plus std. extra of 10%) 30%; with hot pressed hex. nuts up to 1x30-in. (plus std. extra of 10%) 35%

Carriage bolts, ¼x1½-in., per 100, $1.00. Discount on all sizes up to 1x30-in., 30%.

Coach and lag screws, 1½x$\frac{5}{16}$in., $2.25 per 100, less 40%.

Tap bolts, 1½x¼-in., $1.00 per 100. List plus 35% at New York warehouses.

Bolt ends, 1x12-in., 10c. per lb., less 40%.

Nuts, semi-finished, ¼x¼-in., 2c. each. Discount 70% for $\frac{5}{16}$-in and smaller and 65% for ⅜-in. and larger.
Case hardened ¼x¼-in., 6c. each, less 50%

Rivets, button heads, ⅜-in., ½-in.. 1-in. diam. x2$\frac{1}{16}$-in. to 4½-in. $5.00* per 100 lb. at New York warehouses; cone heads, same sizes, $5.20* per 100 lb. Rivets, $\frac{7}{16}$x1-in. and longer, 19c. per lb., less 50%. Same discount for tinned. EXTRA per 100 lb. for 1¼ to 2-in. long, all diameters, 25c.; ⅝-in. dia., 35c.; ¾-in. dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Washers, cast iron, ⅜-in., $7.00* per 100 lb. at New York warehouses; ⅝-in., $6.00* per 100 lb.

*For immediate delivery from warehouse.

Machine Requirements and Industrial Construction

Machine Tools and Equipment Wanted

Ill., Chicago—D. O. James Mfg. Co., 1124 West Monroe St.—gear cutters, planers, etc., (later) for proposed 3 story, 84 x 120 ft. factory.

Ind., Hammond — Frank S. Betz Co.—straight side double crank press.

Mich., Detroit—Detroit Stove Works, 6900 East Jefferson Ave.—equipment for proposed 1 story addition to pattern shop. Estimated cost $50,000.

O., Marietta—E. L. Stephens, Third St.—medium size lathes, drill presses and other equipment for proposed 40 x 90 ft. addition to service station.

Pa., Bristol—Pacific Steel Boiler Corp.—4 ft. radial drill.

Pa., Rochester — Correct Measure Co., Moose Temple Bldg. (gasoline pumps) will receive bids about June 1 for lathes, drill presses and other machinery for proposed new plant at Fallston.

Wis., Milwaukee—P. D. Pearson Co., 128 Grand Ave.—electric drilling machine, reamer, vises and dies.

Opportunities for Future Business

Calif., Los Angeles—J. Kreutzer, c/o E. M. Frasier, Insurance Exchange Bldg., Archt., had plans prepared for the construction of a 3 story auto repair shop on South Hope St. Estimated cost $60,000.

Calif., San Francisco—Pacific Rolling Mill Co., 17th and Mississippi St., will build a 1 story, 125 x 180 ft. shop. Private plans.

Calif., Santa Barbara — Santa Barbara City School Dist., plans an election to vote $600,000 bonds for the construction of a junior high school, including shops, etc.

Colo., Denver—M. L. Foos Hardware Co. has work under way on the construction of a 2 story factory at 19th and Arapahoe Sts. Estimated cost $70,000.

Conn., New Britain—New Britain Spring Co., 706 West Main St., awarded contract for the construction of a 1 story, 27 x 64 ft. addition to factory.

Fla., Ucela (mail Tampa) — Atlantic Coast Line, awarded contract for the construction of a locomotive repair shop. Estimated cost $1,000,000. J. E. Willoughby, Wilmington, N. C., Ch. Engr.

Ill., Chicago—D. O. James Mfg. Co., 1124 West Monroe St., manufacturers of gears, etc., awarded contract for the construction of a 3 story, 84 x 120 ft. factory. Estimated cost $50,000.

Ill., Chicago—R. C. Wieboldt Co., 1534 West Van Buren St., has acquired a site and plans the construction of a machine shop, warehouse, machinery storage building, etc., at Lincoln and Wood Sts. Estimated cost $350,000. Work to be done by owner's forces.

La., Gouldsboro (mail McDonoghville) — Texas & Pacific Ry. Co., has tentative plans for the construction of engine terminals and shops. Estimated cost $1,500,000. E. F. Mitchell, Dallas, Tex., Ch. Engr.

La., New Orleans—American Sheet Metal Works Inc., 3500 South Carrolton Ave., plans the construction of a new 1 story, 165 x 315 ft. plant at Alexandria and Conti Sts., to replace fire loss.

Mass., Boston (Boston P. O.) — J. E. Crowley, Belcher Circle, is having plans prepared for the construction of a 1 story, 60 x 90 ft. repair and service garage on Willard St. Estimated cost $40,000. J. W. Pratt, Bennington Circle, Archt.

Mass., Cambridge (Boston P. O.)—E. Adamson, 73 Tremont St., Boston, awarded contract for the construction of a 1 and 2 story, 90 x 95 ft. repair and service garage on Bay St. here. Estimated cost $50,000.

Mass., Cambridge (Boston P. O.)—National Co., 110 Brookline St., machinery manufacturers, awarded contract for the construction of a 2 story, 45 x 95 ft. addition to factory. Estimated cost $40,000. Noted Apr. 8.

Mass., Dorchester (Boston P. O.)—H. B. Barrow, 36 Abbott St., is receiving bids for the construction of a 2 story, 90 x 120 ft. repair and service garage at Wellington Hill and Glendale Square. Estimated cost $100,000. S. Levy, 39 Court St., Boston, Archt.

Mass., Mariboro—Vialle Motor Co., 15 Union Ave., Framingham, awarded contract for the construction of a 1 story repair and service garage on East Main St. here. Estimated cost $60,000.

Mass., Medfield—C. C. Pierce, awarded contract for the construction of a 1 story, 80 x 120 ft. repair and service garage. Estimated cost $45,000. Noted Apr. 8.

Mass., Roxbury (Boston P. O.)—C. A. Rova, c/o A. O. Bottomley, 10 Tremont St., Boston, Archt., awarded contract for the construction of a 1 story repair and service garage at 220-226 Blue Hill Ave. here. Estimated cost $50,000.

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BUSINESS NEWS DEPARTMENT
McGRAW-HILL CO., INC.,
10th Ave. at 36th St., New York.

Mass., Somerville (Boston P. O.)—Boston Elevated Ry. Co., Park Square Bldg., Boston, had plans prepared for the construction of a 2 story, 45 x 145 ft. garage and repair shop, here. Estimated cost $85,000. A. J. Blackburn, c/o owner, Archt.

Mass., Somerville (Boston P. O.)—A. S. Schatman, Old South Bldg., Boston, awarded contract for the construction of a 1 story, 50 x 110 ft. repair and service garage at 345 Broadway here. Estimated cost $60,000.

Mass., South Boston (Boston P. O.)—Boston Cutting Die Co., E. W. Hanson, 202 A St., is having preliminary plans prepared for the construction of a 1 story factory at Old Colony Ave. and Cottage St. Estimated cost $50,000. Private plans.

Mass., South Boston (Boston P. O.) — Garstein Bros. & Cooper, 1-3 First St., manufacturers of boilers, awarded contract for the construction of a 2 story, 60 x 100 ft. factory at C and First Sts. Estimated cost $50,000.

Mass., Watertown (Boston P. O.)—J. Rubin, 103 Bloomingdale St., Chelsea, awarded contract for the construction of a 1 story, 100 x 150 ft. repair and service garage on Mt. Auburn St. here. Estimated cost $45,000.

Mich., Saginaw—Lufkin Rule Co., manufacturers of steel tapes, rules, measures, etc., awarded contract for the construction of a 2 story factory. Estimated cost $100,000.

Minn., Minneapolis—Ke Hawke Mfg. Co., D. J. Kerner, Pres., 421 South 6th St., awarded contract for the construction of a 2 story, 85 x 124 ft. factory for the manufacture of automobile tire repair shop equipment and allied machinery on Western Ave. $75,000.

Mo., St. Louis — Carter Carburetor Co., 2838 North Spring Ave., had plans prepared for the construction of a 2 story, 35 x 50 ft. factory on Spring Ave. Estimated cost $50,000. W. P. McMahon, 819 Buder Bldg., Archt.

Mo., St. Louis—Herman Body Co., 1831 South 3rd St., manufacturers of auto bodies, awarded contract for the construction of a 1 story, 110 x 204 ft. factory at 1815 North 23rd St.

N. J., Trenton—City Commission awarded contract for the construction of a 2 and 4 story fire headquarters and machine shop on Perry St. $268,896. Noted Apr. 22.

N. Y., Brooklyn — F. Savignano, 6005 14th Ave., is having plans prepared for the construction of a repair and service garage at 8124 18th Ave. Estimated cost $100,000.

N. Y., Massena—Aluminum Co. of America, Oliver Bldg., Pittsburgh, Pa., is having plans prepared for the construction of a 1 story, 150 x 310 ft. wire mill here. Estimated cost $350,000. Private plans.

N. Y., New York—Packard Motor Car Co., East Grand Blvd., Detroit, Mich., will receive bids until May 15 for the construction of a 5 story, 100 x 200 ft. repair and service garage at Columbus Ave. and 61st St. here. A Kahn, 1000 Marquette Bldg., Detroit, Mich., Archt.

N. Y., New York—Water Supply, Gas & Electricity Dept., Municipal Bldg., plans the construction of a shop, storage warehouse and distribution building on Jerome Ave. Estimated cost $100,000. Private plans.

N. Y., Rochester—Steele & Stone, 208 National Bank Bldg., is having plans prepared for the construction of a 6 story, 106 x 150 ft. garage at Achilles and Stillson Sts. Estimated cost $300,000. R. O. Derrick, 120 Madison Ave., Detroit, Mich. and Gordon & Kaelber, Sibley Block, Rochester, Assoc. Archts.

N. Y., Yonkers—American Radiator Co., 40 West 40th St., New York, is having plans prepared for the construction of a laboratory on Bronx River Road here. Estimated cost $100,000. L. Quick, South Broadway, Yonkers, Archt.

Pa., Fallston (mail New Brighton)—Correct Measure Co., Moose Bldg., Rochester, manufacturers of gasoline pumps, awarded contract for the construction of a 1 story, 140 x 150 ft. factory, here. Estimated cost $100,000.

Pa., McKees Rocks—Enterprise Stamping Co., awarded contract for the construction of a 2 story, 100 x 250 ft. addition to manufacturing plant and warehouse. Estimated cost $150,000. Noted Feb. 25.

Pa., Philadelphia—General Electric Co., awarded contract for the construction of buildings 9, 10 and 11 to be 7 story, 74 x 100, 106 x 601 and 74 x 103 ft. on Elmwood Ave. Estimated cost $1,500,000. Noted Apr. 15.

Pa., Williamsport — Williamsport Buick Co., c/o J. H. Bubb, 405-411 West 3rd St., will receive bids until May 15 for the construction of a 3 story, 116 x 149 ft. garage and repair shop on West 3rd St. Estimated cost $150,000.

Pa., Williamsport—Williamsport Development Co., L. H. Frantz, Pres., manufacturers of composition valve packing, will receive bids until May 15 for the construction of a 1 story, 80 x 100 ft. factory. Estimated cost $50,000.

Tex., Pecos—Pecos Valley Southern Ry. Co., L. W. Anderson, V. Pres. & Gen. Mgr., plans the construction of an office building and railway shops. Estimated cost $200,000. J. R. Smith, 310 Blackburn Bldg., Amarillo, Archt.

Wis., Madison — A. C. Fosdick, 1634 Schiller Court, awarded contract for the construction of a 1 story, 60 x 90 ft. machine shop on Division St.

Wis., Platteville—Russell Foundry Co., F. Russell, Mgr., plans the construction of a 1 story, 38 x 110 ft. foundry. Estimated cost $40,000. Architect not selected.

Wis., Racine—Belle City Malleable Iron Co., Kewaunee St., awarded contract for the construction of second unit to foundry, 1 story, 118 x 200 ft.